

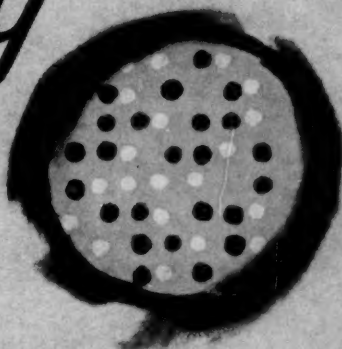
# *Chemical Engineering*

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SEPTEMBER 7, 1959

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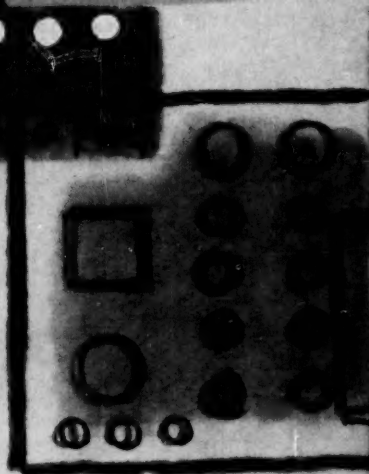
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WHAT YOU NEED TO KNOW ABOUT

## **COMPUTERS**

FOR PROCESS DESIGN, RESEARCH  
AND PLANT ECONOMICS





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*When it's hot it pours!*

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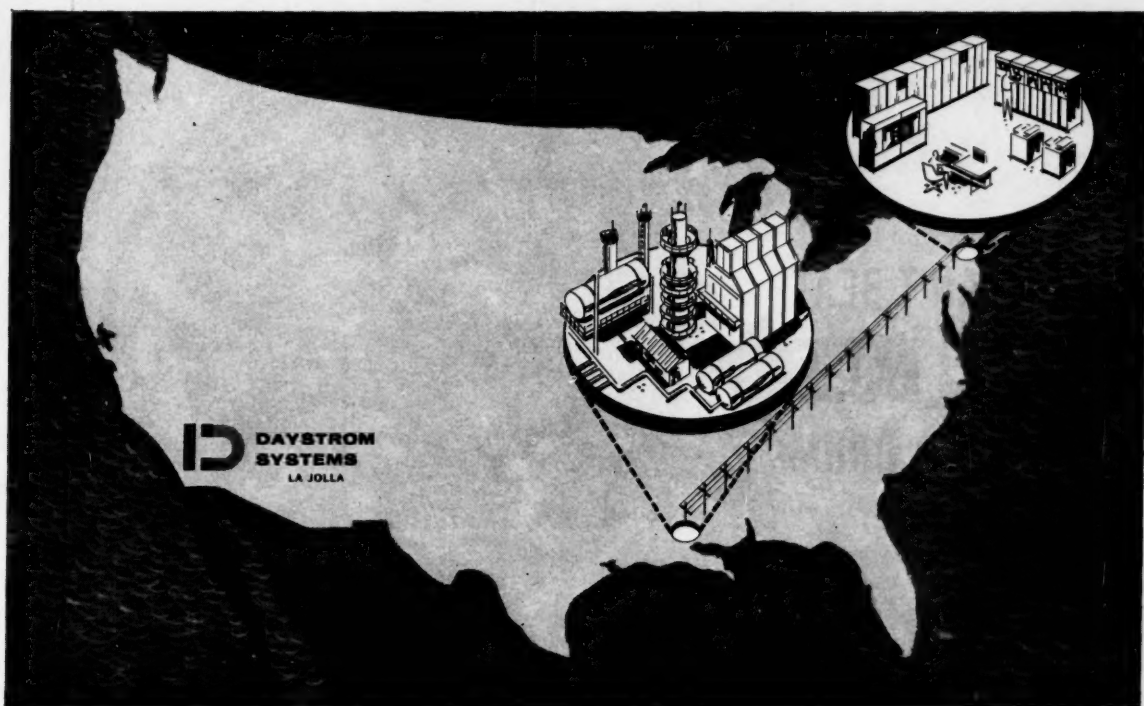
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## Operating and test data reduction via telephone link utilizing any computer facility

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For the first time, the TPR (tape programmed raw) data scanner makes it possible and practical to link a test or operational plant facility directly to any computer in the country for instant computation of data. This is made possible by the utilization of standard telephone communication services, and permits stationing of all engineering and computer programming personnel at the project site, where all phases of the work may be handled.

The importance of this development is brought into sharp focus by the almost non-existence of computer facilities at actual plant or test sites. The utilization of tele-

phone circuits completely circumvents this problem since it makes little difference whether the computer facility to be used is located in an adjoining building, company headquarters or at a rental facility. Distance represents no problem other than nominal telephone service charges.

Telephone communication of this type is a practical reality in the business machine field and is being used every day by leading companies for inventory control, accounting and other purposes. The Daystrom TPR Data Scanner is the first system that has been specifically designed to handle the problems involved in gathering large amounts of analog data peculiar to plant and test facility operation.

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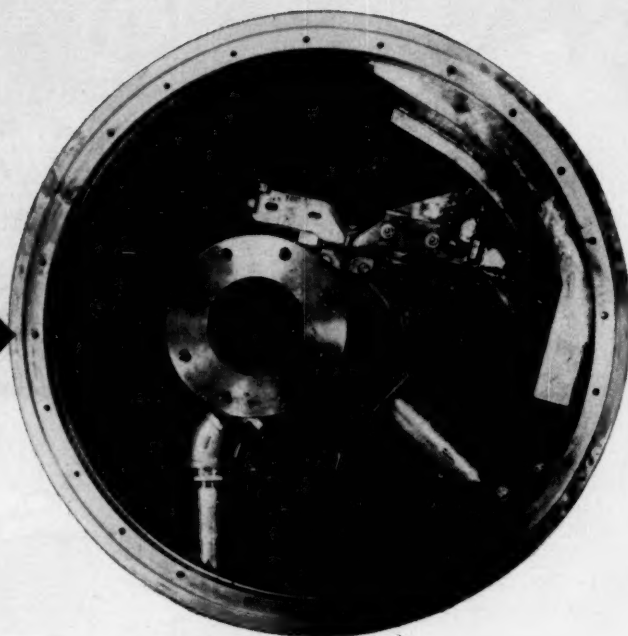
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*Typical 2000 point system delivered to a major nuclear propulsion test facility.*

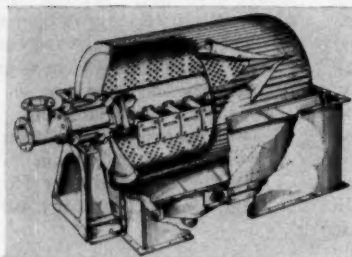
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CAN'T BEAT  
THIS  
DRUM**



## **For handling high Filtrate Volumes**

Look inside this Bird-Young Vacuum Filter drum. In operation it is entirely under vacuum, with the vacuum 100% effective directly under the cloth. Note the absence of internal piping. Filtrate flow is completely unrestricted.



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September 7, 1959

# Chemical Engineering

Vol. 66 No. 18

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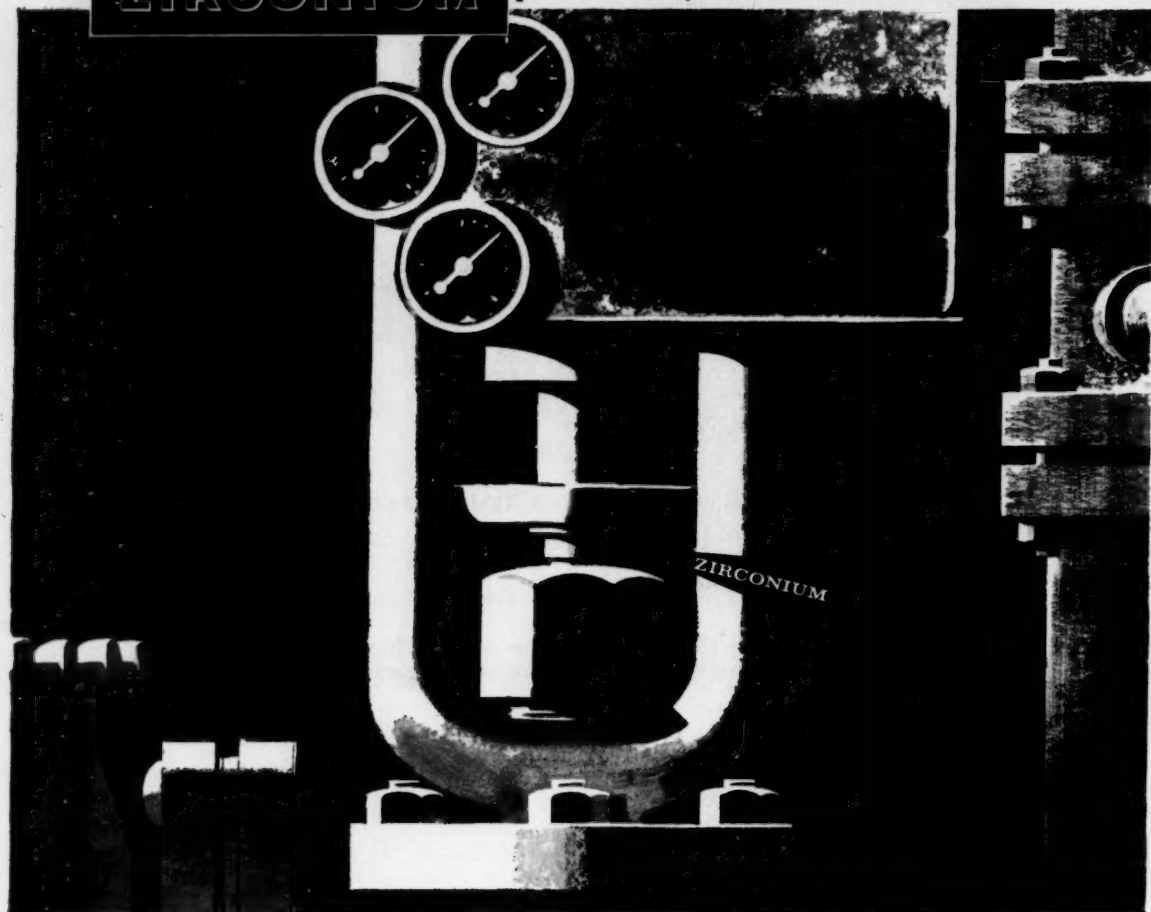
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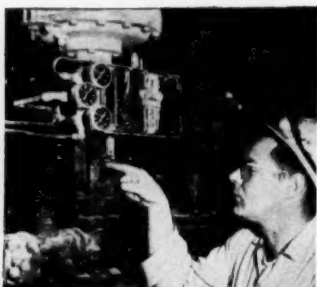
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# ZIRCONIUM

*proves ideal for corrosive acid service*



## ZIRCONIUM VALVE STEMS OPERATING 27 MONTHS WITHOUT FAILURE



*Zirconium-stemmed control valve, one of 40 still in operation after 27 months of acid service...at Mallory-Sharon sponge-reduction plant in Ashtabula, Ohio.*

Here's a case history story we can vouch for personally. At the Mallory-Sharon sponge-reduction plant in Ashtabula, Ohio, 40 zirconium-stemmed control valves have been operating for over 27 months—*without a single stem failure!*

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Why not take advantage of Mallory-Sharon's production and application know-how in zirconium? Write us about your corrosion problems...or request Technical Data Sheets on "Physical and Mechanical Properties of Zirconium".

### MALLORY SHARON

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*Integrated producer of Titanium • Zirconium • Special Metals*

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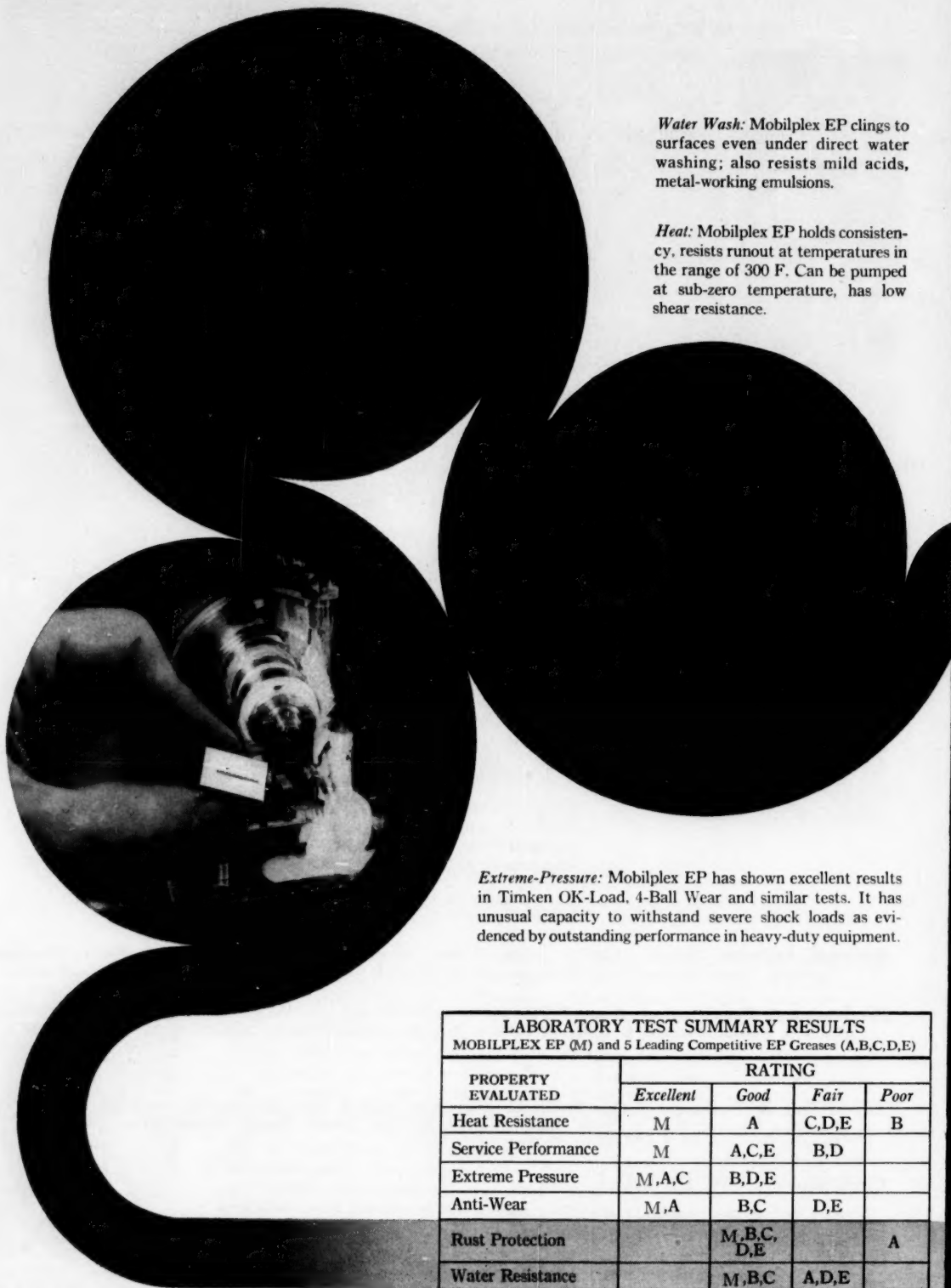
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Heat Resistance	M	A	C,D,E	B
Service Performance	M	A,C,E	B,D	
Extreme Pressure	M,A,C	B,D,E		
Anti-Wear	M,A	B,C	D,E	
Rust Protection		M,B,C,D,E		A
Water Resistance		M,B,C	A,D,E	
Handling Properties		M,A,B,C,D,E		
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Non-staining		M	A,B,D,E	C

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*The Multi-Service\* Grease with unique Calcium EP Complex. Never before in a single lubricant such a wide range of use . . . such a margin of superiority . . . such a potential for maintenance savings!*

From Mobil research comes Mobilplex EP . . . a Multi-Service extreme-pressure grease far superior in quality and range of applications to any multi-purpose grease available.

The unique Calcium EP Complex, special additives and extremely tenacious nature of Mobilplex EP, provide maximum protection against wear, rust, washout and heat. Because of its greater versatility, Mobilplex EP goes further than competitive extreme-pressure greases in simplifying your lubricant application, storage and purchasing problems. This new-type lubricant has given industrial machines greater protection while replacing as many as seven other greases. Mobilplex EP has all of the advantages usually associated with EP greases—as well as excellent storage, structural and oxidation stability.

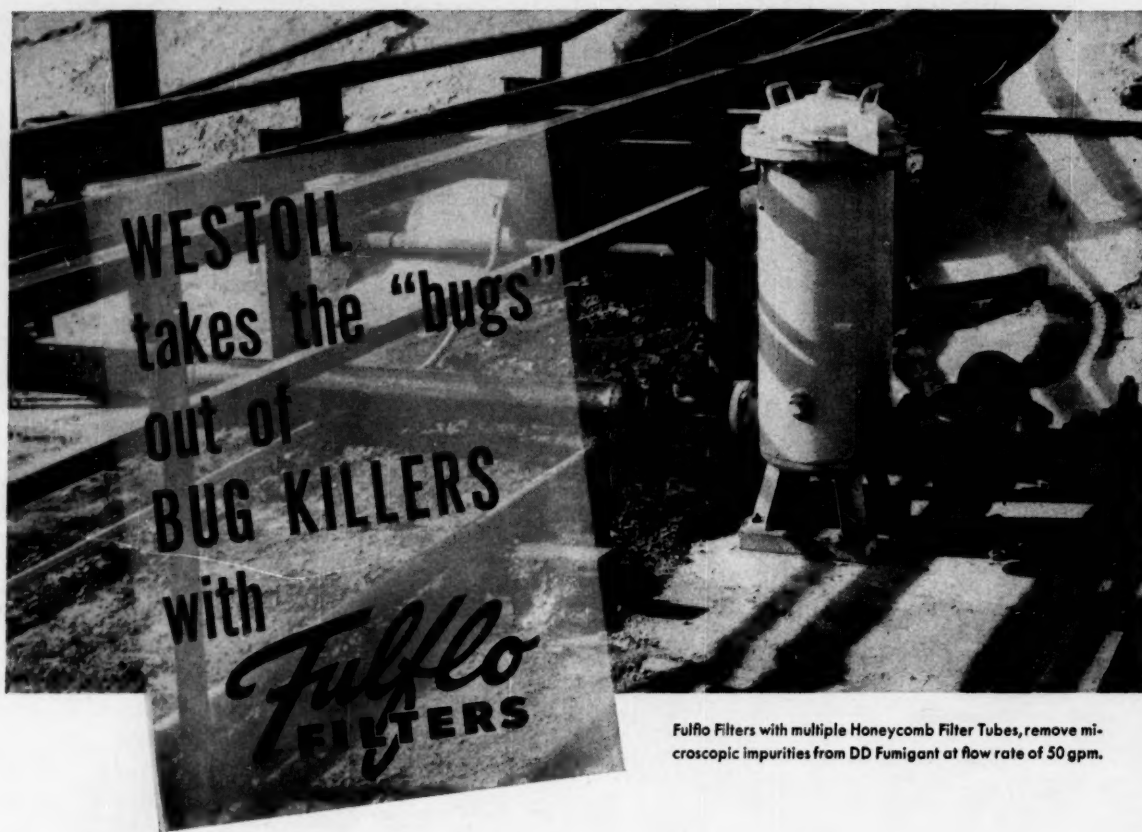
Examination of the laboratory summary at left shows that in comparison with five leading extreme-pressure lubricants Mobilplex EP is the *only* grease excellent or good in every grease quality tested. No wonder aluminum and steel plants, forging and metal-drawing shops, the cement, chemical and rubber industries, steel and paper mills are reporting dramatic success with Mobilplex EP.

For full details contact your Mobil representative.



\*Multi-Service means ideal for all types of anti-friction and plain bearings under all normal operating conditions (temperatures in the range of 300 F.) and for all types of dispensing equipment.

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Fulflo Filters with multiple Honeycomb Filter Tubes, remove microscopic impurities from DD Fumigant at flow rate of 50 gpm.

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Fulflo Filters with genuine Honeycomb Filter Tubes, improve product quality, reduce downtime, prolong equip-

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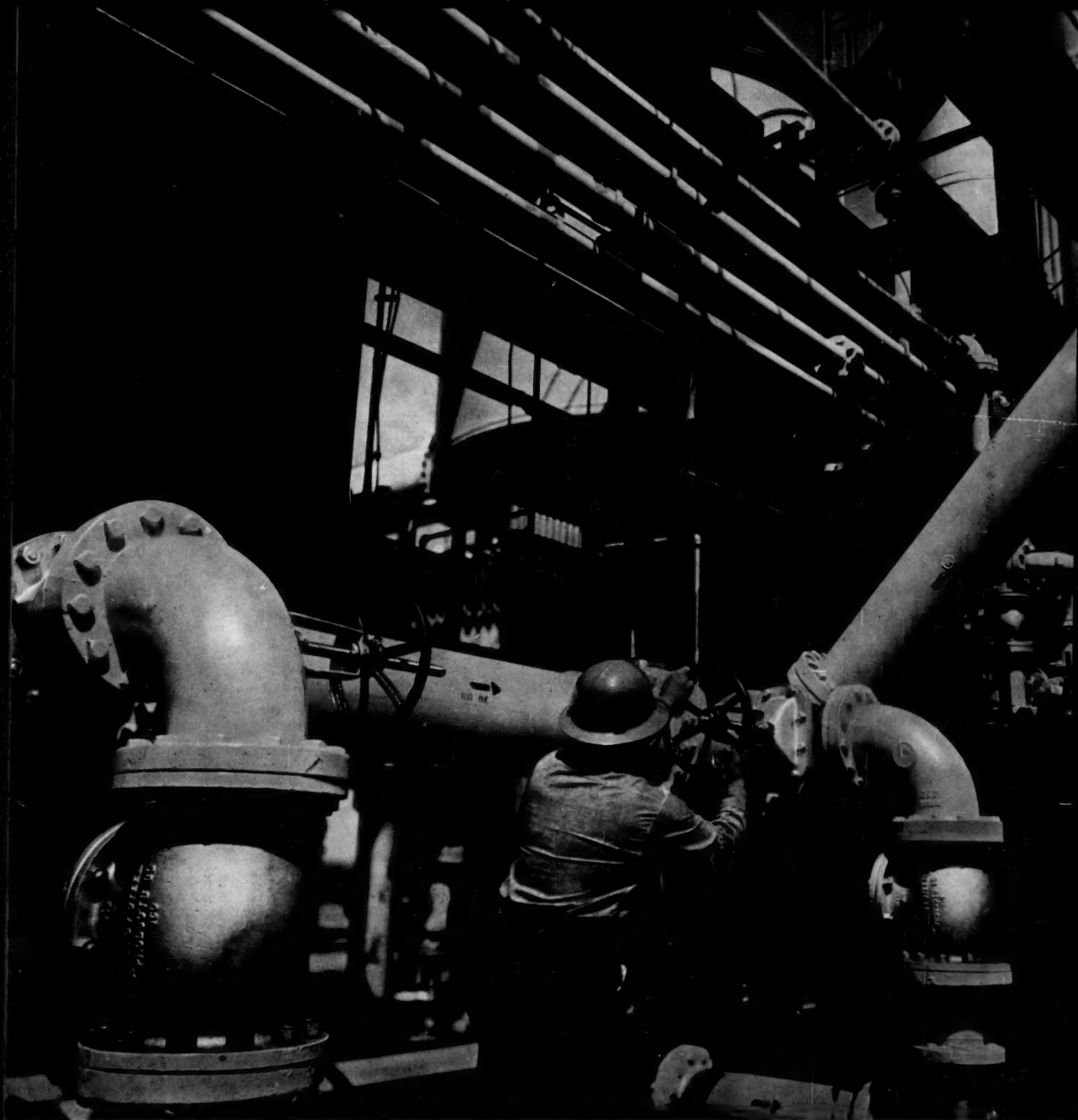
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with genuine Honeycomb Filter Tubes for controlled micro-clarity of industrial fluids.



Selective filtration of oils • water-oil separators • magnetic separators • pre-coat filters • coolant clarifiers • automatic tubular conveyors.



## Aloyco Valves in General Chemical's new "dream" plant

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The plant utilizes most modern processing techniques. All equipment was chosen for its special ability to contribute to operating efficiency and long life.

For example, valves made in Aloyco 20,

an alloy exceptionally resistant to corrosion from sulfuric acid, were specified for handling spent and sludge acids, as well as finished strong acid and oleum.

When you are selecting valves for corrosive service, remember only Alloy Steel Products Co. specializes in Stainless Steel Valves exclusively. Call our local representative or write us at 1301 West Elizabeth Avenue, Linden, N. J. © 2

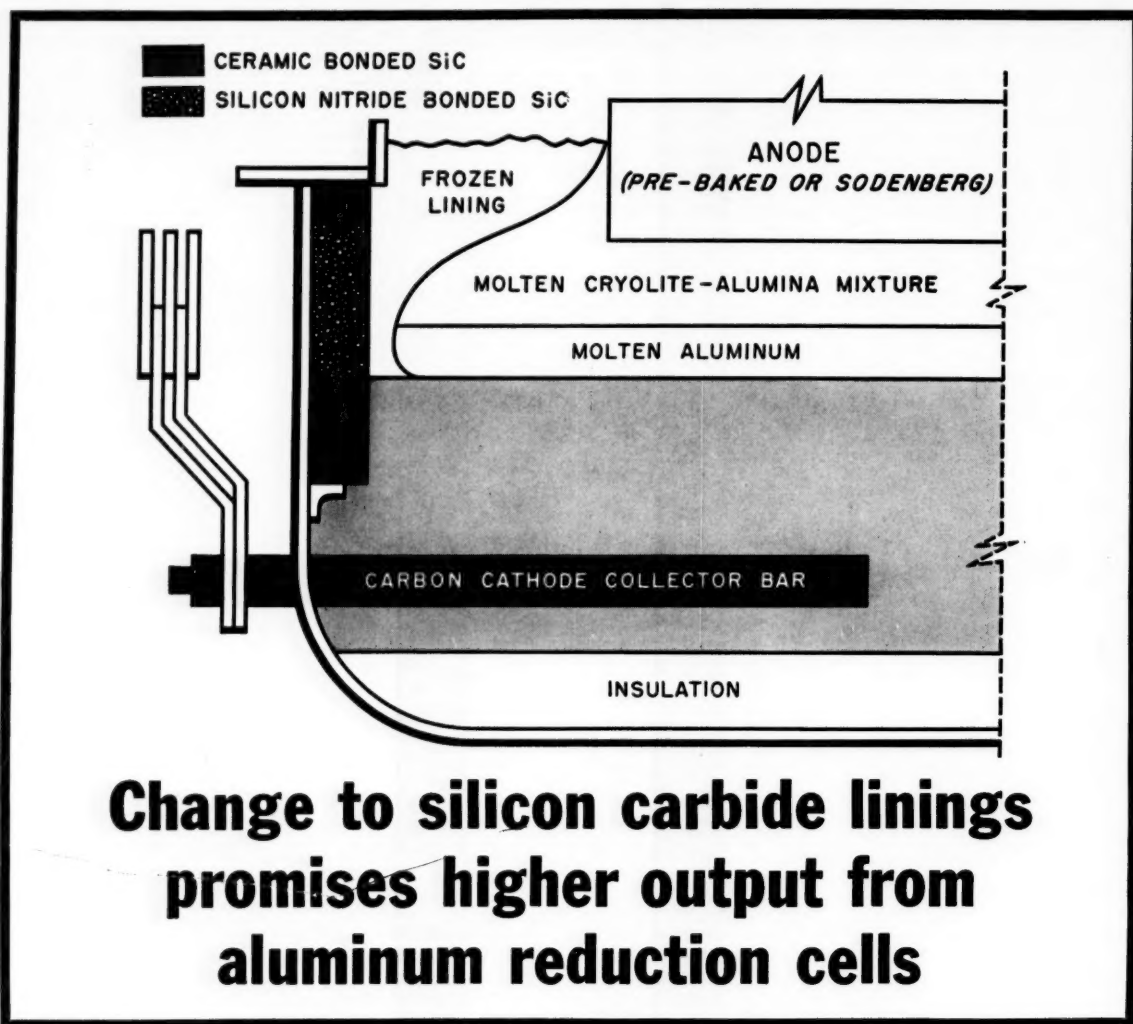


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*Another industry development with Carborundum's refractories:*



## Change to silicon carbide linings promises higher output from aluminum reduction cells

Primary aluminum producers are now looking to silicon carbide refractories as a means of lowering costs and increasing output from existing pot lines. Here's how:

Standard electrolytic reduction cells have long used 8 to 13 inch-thick carbon-block linings to resist the action of the molten cryolite electrolyte, which rapidly attacks almost all materials. The use of silicon carbide promises a reduction of lining thickness to as little as 3", resulting in greatly increased cell capacity.

Key to the successful use of silicon carbide is its high thermal conductivity. This not only prevents the side walls from overheating but also protects the lining itself. Heat is conducted away so rapidly that a layer of electrolyte freezes on the lining surface, forming an effective barrier against attack and abrasion.

Experience points to the use of the new silicon-nitride-

bonded silicon carbide, which has a particularly high resistance to chemical attack, for the more vulnerable spots, while the lower-cost conventionally bonded product can be used in other areas.

Developments like this show how corrosive melts are frozen on Carborundum's refractory linings to resist high-temperature attack . . . attack that quickly destroys most ceramic materials. If you have such a problem, perhaps one of Carborundum's refractories can give you just the combination of properties you need.

Write today for your free copy of "Super Refractories by Carborundum." The address: Dept. H-99, Refractories Division, Perth Amboy, New Jersey.



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## Giant refineries like Esso Baton Rouge use Sola-Flex® Expansion Joints

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Solar manufactures the most comprehensive line of expansion joints in the world. They are made in a wide variety of stainless and high-temperature alloys in a complete range of sizes, from ½ in. to 35 ft in diameter. Temperatures range from -320F to 1200F; pressures from complete vacuum to 600 psi and up. *And rugged, economical Sola-Flex joints can be "in service"*

*one to four weeks after receipt of order!*

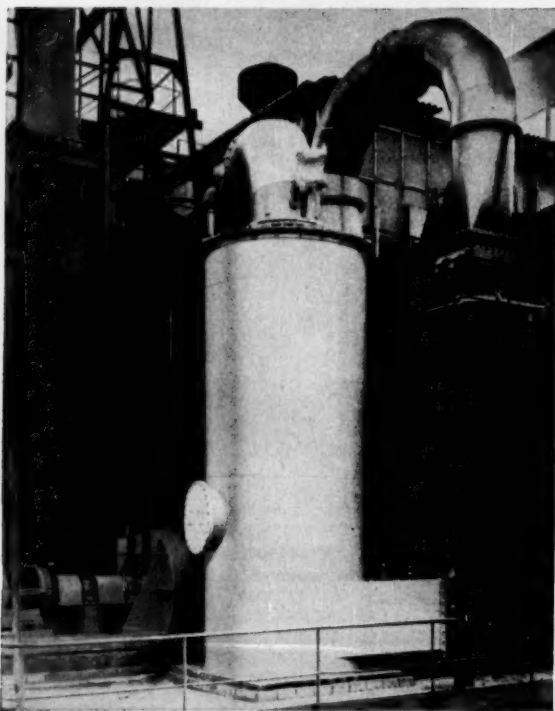
A new pamphlet describes Solar's complete line of Sola-Flex expansion joints. Write for it to Dept. G-42, Solar Aircraft Company, San Diego 12, Calif.



# AIR POLLUTION

*growing problem in the chemical industry*

## Chemico Gas Scrubbers offer practical solution in variety of CPI applications



The Chemico venturi scrubber installed on this phosphoric acid plant removes and recovers better than 99% of the phosphoric acid mist. In this instance, both venturi and cyclonic separator are rubber-lined to withstand the effects of the acid.

### FULL DETAILS AVAILABLE

For your copy of a new brochure giving complete data on Chemico venturi gas scrubbers or for technical assistance on a specific problem, write to the address below.

Dusts, fumes and mists—the unavoidable by-products of many industrial processes—often create tremendous public relations and legal problems. The chemical industry is now taking vigorous steps to remove these nuisances.

One such step has been the application of Chemico venturi gas scrubbers which remove sub-micron as well as plus-micron particles from gas streams, thereby eliminating the polluting elements. These units are based on the Pease-Anthony venturi principle which has been modified and improved by Chemico.

• • •

### OUTSTANDING PERFORMANCE ON DIFFICULT PROBLEMS

Typical of the success of Chemico venturi gas scrubbers has been their recent application to sulfuric acid concentrators which have long been a source of air pollution. By the use of this equipment, better than 99% of the acid mist can now be removed, thus solving this difficult pollution problem.

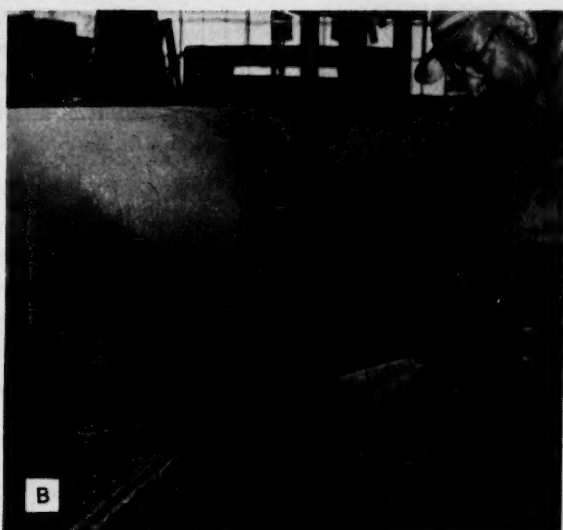
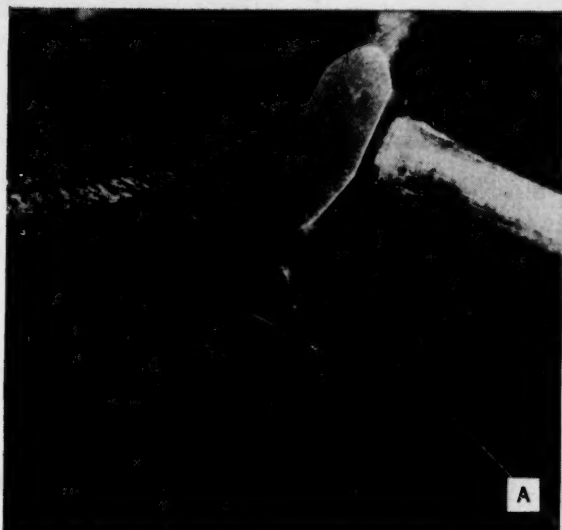
### SIMPLE CONSTRUCTION PERMITS WIDE APPLICATION

The simple design of Chemico venturi gas scrubbers allows for use of materials resistant to corrosion, abrasion or high temperature. This, plus their small space requirements, permits installation in existing plants handling corrosive materials as well as incorporation into new plant designs. In addition, no critical controls are required and maintenance costs are reduced to the barest minimum. Chemico venturi scrubbers have been proven for use in acid concentrators, copperas roasting kilns, chlorosulfonic acid plants, dry ice plants, phosphoric acid plants and many other chemical manufacturing operations. These are the same scrubbers which won such wide acceptance in the iron and steel industries.



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You may wish to check certain items in this advertisement and forward to those concerned in your company.

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# CHEMICAL 'COOK' ELIMINATES PROCESSING FAILURES

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From potato chips to automobile parts, these products have traditionally been processed using direct fire or steam. Each system has had inherent drawbacks, . . . the potential hazard of fire or the high cost of equipment to

handle steam at high pressures. And neither has been notably satisfactory in making it easy to keep temperature gauges from wavering.

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Equipment for the use of Dowtherm A often pays for itself in three to five years through reduced costs and improved production.

cause the heat source for systems using Dowtherm A can be located at a safe distance from the actual processing operation, the danger of fire is greatly reduced.

Contrasted to the heavy, high cost equipment necessary to contain 700° steam under more than 3,000 pounds pressure, Dowtherm A at the same temperature takes light handling because it exerts only 110 pounds pressure per square inch.

The singular attraction of Dowtherm A as an unequaled medium for precision heat transfer has led hundreds of processors to install new or modified equipment to handle the chemical. But then other dividends accrued, too. These processors have found that systems using Dowtherm A were actually self-liquidating in three to five years time through reduced insurance rates, decreased operating and maintenance costs, improved production.

Dowtherm A has been used for more than 10 years with outstanding success to mold plastics and rubber products, distill fatty acids, process paints and varnishes, manufacture linoleum and in a wide variety of other applications in food processing, chemical processing and metal plating.

**Special Dowtherm products** now have been developed for profitable new uses. Examples are Dowtherm SR-1 for sub-surface snow removal systems and Dowtherm 209, a freeze point depressant for ebullient cooling.

★ ★ ★ ★

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## METHOCEL:

**These gums stretch over widest viscosity range**

Versatile, synthetic gums are expanding into new areas of textiles, paper, food and paint manufacture. And a big reason for this expansion has been the wide usefulness of Dow's family of synthetic gums with the widest viscosity range . . . the Methocel® products.



60-page Methocel Book describes properties and uses of versatile synthetic gums.

With available viscosities ranging from 10 cps. to 15,000 cps., Methocel gums have shown exceptional capabilities as thickeners, stabilizers, film formers, emulsifiers, suspending agents and binders.

These water-soluble, nonionic gums have a profitable performance record in improving products and processes . . . from basic viscosity control to conquering such complex problems as suspension polymerization. It takes no stretch of the imagination to discover their potential usefulness in your business. A close look at the most recent 60-page book on Methocel products will show you.

## One-stop shopping for POLYOLS

In the colossus of the modern department store, you'll see occasionally a sign which says something to the effect, "If you can't find what you're looking for . . . just ask for it".

The chemist or processor looking for the right polyols for his own particular application will find the same assurance of supply in the Dow inventory of these basic chemicals, accurately labeled "world's widest line of polyols".

This amounts to more than just purchasing convenience, however. It means the men at Dow have much to offer the polyol user, too, in the way of technical service, research information and new polyol products for experimental use as intermediates, plasticizers, emulsifiers, lubricants, antifoamers, coolants, solvents and other products.

## DOW CHEMICALS basic to the chemical processing industry

Alkylene Oxides, Glycols  
Industrial Preservatives • Glycol Ethers  
Polyalkylene Glycols • Alkalies  
Phenolic Compounds • Brominated and Chlorinated Aliphatic Compounds  
Inorganic Acids • Halogens  
Organic Acids and Esters  
Inorganic Chlorides, Bromides and Bromates • Nitrogen Compounds  
Amino Acids • Glycerine • Salicylates  
Phenyl Phosphates • Chelating Agents  
Flotation and Flocculating Agents  
Heat-Transfer Media • Methylcellulose  
Ion Exchange Resins • Magnesium  
Plastics • Aromatics

**THE DOW CHEMICAL COMPANY**  
Midland, Michigan

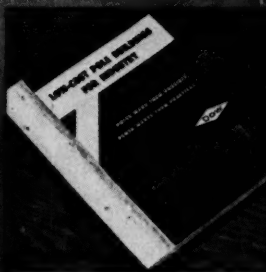


## DOW CHEMICALS . . . well worth noting



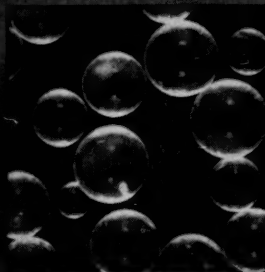
### PHARMACEUTICALS

Dow supplies imposing list of pure, high quality pharmaceutical chemicals such as bromine, medicinal salicylates, epsom salt, chloroform, analgesic drugs, elemental iodine.



### PENTACHLOROPHENOL

New 12 page booklet—"Low-Cost Pole Buildings for Industry"—describes in detail low costs and long lasting benefits of penta-treated pole buildings. Write for copy today!



### ION EXCHANGE RESINS

Dowex® 50W, white cation resin with excellent bead strength and uniformity, is newest member of Dowex products for many industrial processing applications.

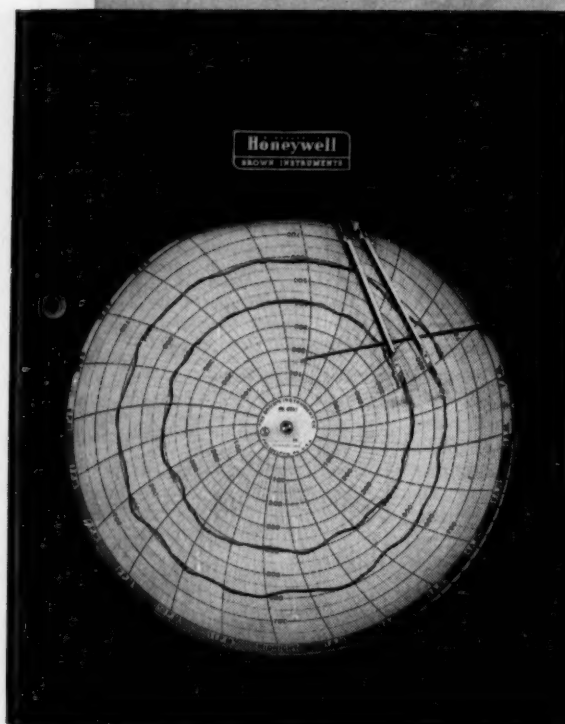


### BROMINE

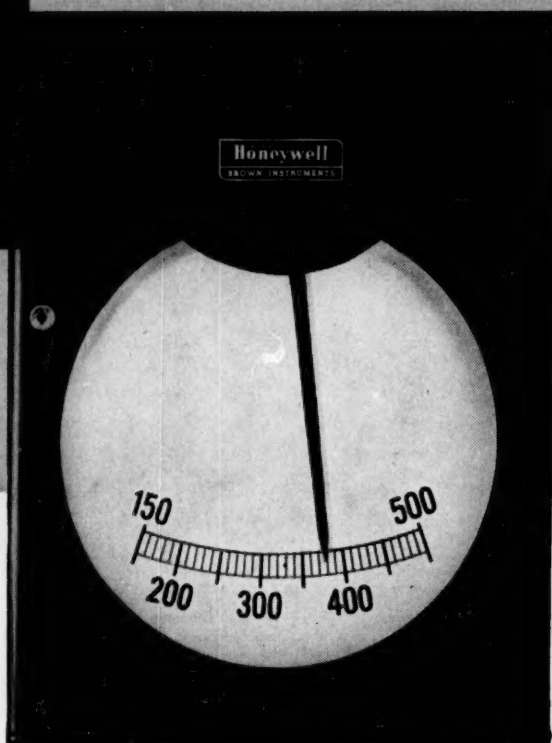
Most grades of bromine and brominated products are available from Dow where nearly 70 years of leadership in research, know-how and production are at your disposal.

Choose from thousands of Honeywell

# Temperature



Both thermometers and pressure gages are available in recorder and indicator models.



Instruments to measure and control

# and Pressure

The enormous variety of options available in Honeywell thermometers and pressure gages gives you custom design in standard instruments. Choose from *thousands* of combinations of pressure and thermal elements, chart and scale ranges, transmitting, receiving and pneumatic or electric control units.

Use Honeywell thermometers to measure temperatures from  $-125^{\circ}\text{F}$  to  $1000^{\circ}\text{F}$ , with accuracy of  $\pm 1\%$ . Measure pressures as high as 4000 psi and as

low as 5 inches of water vacuum with Honeywell pressure gages.

Whatever your requirements in temperature and pressure measurement and control, there's a Honeywell instrument virtually made to order for you. Get complete details from your nearby Honeywell field engineer. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

## CONTROL COMBINATIONS AND OPTIONS

### TEMPERATURE

**Thermal systems**—vapor, mercury, or gas actuated, case, case and capillary, or self-compensated.

**Bulb styles**—plain, union-connected, averaging, preformed capillary, rigid extension, dairy, wet and dry bulb assemblies, self-contained thermal systems.

**Electric control**—*Electr-O-Vane*, spst (on-off control), spdt (two-position control), sp3t (three-position control).

**Pneumatic control**—On-Off

10% *Throttlor* (1 to 10% proportional band, manual reset).

Full *Throttlor* (1 to 150% proportional band, manual reset).

*Air-O-Line* (1 to 150% proportional band, automatic reset).

For complete information, write for Catalog C-60-2. ▶



### PRESSURE

**Pressure and vacuum elements**—spiral, intermediate-range spring and bellows, low-range spring and bellows, dual spring and bellows for absolute pressure.

**Electric control**—*Electr-O-Vane*, spst (on-off control), spdt (two-position control), sp3t (three-position control).

**Pneumatic control**—On-Off

10% *Throttlor* (1 to 10% proportional band, manual reset).

Full *Throttlor* (1 to 150% proportional band, manual reset).

*Air-O-Line* (1 to 150% proportional band, automatic reset).

For complete information, write for Catalog C-70-1. ▶



# Honeywell



*First in Control*

# How lasting quality is Heat Exchanger

Drawing is a basic tube fabrication operation that transforms newly extruded tubes into standard and special size tubes for various applications. Phelps Dodge uses the cold-drawing process, a method in which precise control and master craftsmanship are combined to produce tubes that meet the most exacting specifications.

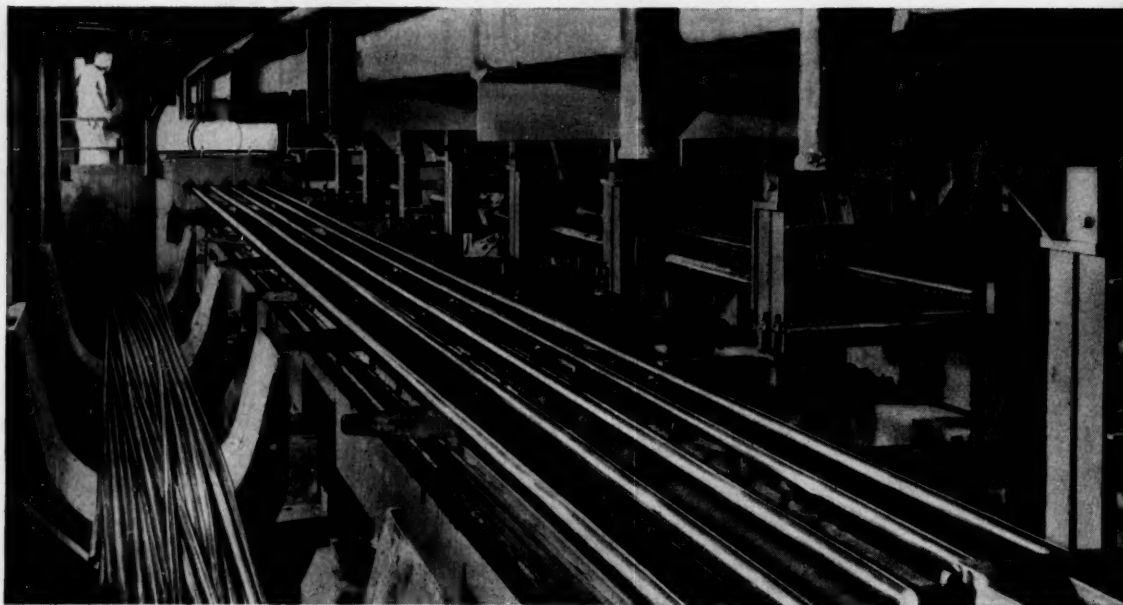
The cold-drawing method is used throughout, because it assures maximum tube quality through carefully coordinated operations on a drawbench where simple axial tension is applied.

After initial lubrication the tubes are brought to the drawbench. Each tube is slipped over a mandrel and hollow supporting rod, then drawn through a die and over the mandrel to form a tube of the desired diameter and wall thickness. Continuous lubrication is applied to each tube

during this operation to control surface quality and minimize heat generated during the processing cycle.

Dual-gauge tubing is the result of a modified drawing operation which was developed by Phelps Dodge. In this operation, a heavier wall thickness is provided at one or more points of the tube length to compensate for thinning of the outer portions of return bends. In this manner, uniform thickness is retained where ordinary tubes thin out.

Throughout the entire tube fabricating operation—from raw materials to finished product—quality is the keynote. That's why Phelps Dodge tubes are preferred by those who demand the finest . . . the manufacturers and users of heat exchangers and condensers.



In automated drawing operation at new Phelps Dodge mill, tubes are pulled through reducing dies into smaller diameters and longer lengths.

# built into Phelps Dodge and Condenser Tubes...

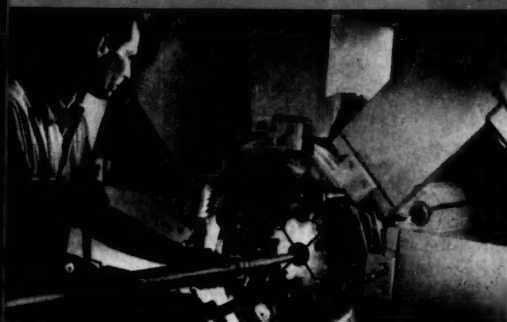
# 3

## DRAWING

(THIRD OF A FIVE-PART SERIES)



Cutaway of Dual-gauge tube;  
note how extra metal provides  
additional safety factor by  
retaining uniform wall thickness  
at return bend.



Pointing one end of an extended  
copper shell, a preliminary step  
in the drawing process.

## PHELPS DODGE COPPER PRODUCTS CORPORATION

*First for Lasting Quality—from Mine to Market!*

**SALES OFFICES:** Atlanta, Birmingham, Ala., Cambridge, Mass., Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Dayton, Denver, Detroit, Fort Wayne, Greensboro, N. C., Houston, Indianapolis, Jacksonville, Kansas City, Mo., Los Angeles, Memphis, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Richmond, Rochester, N. Y., San Francisco, St. Louis, Seattle, Washington, D. C.



# FLUIDICS



FLUIDICS AT WORK

## Data on ion exchange as a unique unit operation

Have you considered ion exchange as a unit operation?

If you're used to thinking of ion exchange as only a method for purifying boilerfeed and process waters, you will be glad to learn that this same process can be a valuable aid in performing other functions.

Ion exchange is often far more efficient than other type unit operations, particularly where solutions are dilute—less than 2500 ppm, generally speaking.

We'll be glad to send you data concerning ion exchange usage for removing impurities from solution, for concentration and separation of dilute electrolytes in solution, for addition of specific ions to solution, and for catalysis, both acidic and basic.

We'll also send complete information on Permutit ion exchange resins and process equipment. Just circle "A" on the coupon.



FLUIDICS AT WORK

## How ultra high purity water helps RCA produce COLOR TV tubes

Water used for washing the inside surfaces of RCA color TV picture tube envelopes must be ultra pure. Even a trace of iron or copper might discolor or deaden the sensitive phosphor coating that reproduces the color picture.

At RCA's Lancaster plant, washing was first done with distilled water. When tube production outgrew the capacity of the distillation equipment, RCA put in its first manually operated ion exchange units. When these, too, fell short of requirements, RCA called in Permutit to enlarge and modernize the complete demineralizing facilities.

Now the entire process is operated from one master control panel. There's plenty of water for production . . . and dissolved mineral content is even lower than when the water was distilled.

For more information on this process we refer you to the item on the left and to the letter "B" on the coupon.



FLUIDICS AT WORK

## Do you have problems with wastes? Send for this bulletin

Here in eight pages you'll find concise comments on modern methods and equipment used for controlling, treating, and reclaiming industrial wastes.

The bulletin covers such knotty problems as reclaiming chromates, acids, and other valuable materials . . . removing fats and greases . . . neutralizing waste waters . . . complying with anti-pollution laws . . . etc.

Equipment described includes Precipitators, Colloidair Separators, chemical feeders, filters, ion exchange units, evaporators, meters and flow controllers, and CO<sub>2</sub> indicators.

There is also an outline of the complete engineering and testing services available from Pfaunder Permutit.

If waste is one of your problems and you want to know some of the practical answers, just circle "C" on the coupon for a copy.

# FLUIDICS

is a Pfaudler Permutit program providing the know-how the equipment and the experience for solving problems involving fluids.

FLUIDICS covers such varied phases of fluid handling and control as:

- water treatment
- waste treatment
- corrosionproofing
- reactions
- polymerization
- ion exchange
- fluid analysis, metering and control
- agitation
- evaporation
- distillation
- drying
- blending
- metering
- valving
- flow rate control
- pipng
- storing
- centrifuging
- filling
- heat transfer, etc.

Whenever you have a fluid-handling problem, look to this Pfaudler Permutit FLUIDICS program for the best solution.

## FLUIDICS AROUND THE WORLD

Pfaudler Permutit is a world-wide company with manufacturing plants in these countries:  
 Germany: Pfaudler-Werke A.G.  
 Great Britain: Enamelled Products Corp. Ltd.  
 Canada: Ideal Welding Co. Ltd.  
 Mexico: Arteacero-Pfaudler, S.A.  
 Japan: Shinko-Pfaudler Co., Ltd.



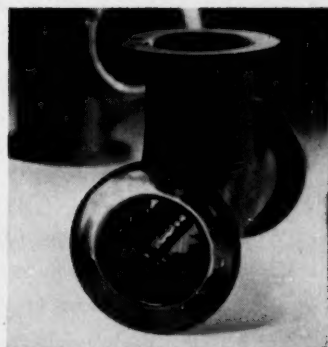
## FLUIDICS AT WORK

### For low-cost gas analysis or control

If the gas component you want to measure or control is related to the specific gravity of the gas, a RAN-AREX will measure it accurately, continuously, without lag and at low cost.

Works on a simple, mechanical principle . . . rugged, foolproof. Can be equipped for automatic control. Analyzes flue gas to cut fuel costs . . . aids quality control in heat-treating, chemical processing, oil refining . . . checks uniformity of fuel gas, etc.

For details and complete specifications, circle "D" on the coupon.



## FLUIDICS AT WORK

### Glassed ductile iron\* fittings with strength comparable to Glasteel's

Now you can get glassed, ductile iron fittings that are 2½ to 3 times as strong as conventional gray iron.

60,000# tensile strength, 45,000# yield, 15% elongation.

Thermal shock resistance is now comparable to Glasteel 59's. Corrosion resistance is also the same as Glasteel's . . . handles all acids except hydrofluoric.

July 1st delivery on 45° and 90° elbows, tees, and crosses in 1½-, 2-, 3-, 4-, and 6-inch sizes.

Circle "E" on coupon.

\*Patent Pending

## PFAUDLER PERMUTIT INC.

Permutit Div., Dept. CE-59, 50 W. 44th St., N.Y. 36, N.Y.

Circle item wanted: A B C D E

Name.....

Title.....

Company.....

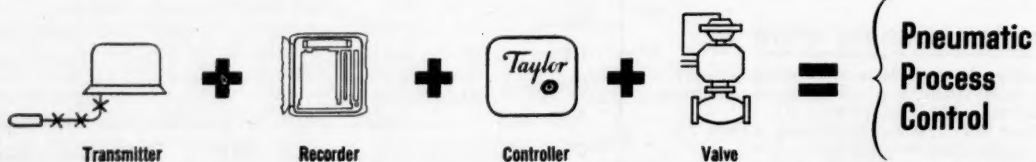
Address.....

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*The best Control System  
is the one  
Tailored  
to your Control Problem*



PNEUMATIC SYSTEMS



# 475 years of Cumulated Experience will be at Your Service in Taylor Booths 444 and 545 at the ISA Show

**W**HETHER you are interested in a complete control system, or in one of our new developments, the team of top Taylormen listed here will be at the ISA Show in Chicago to consult with you.

Drawn from our Application Engineering, Design Engineering, and Sales Departments, these men have behind them many years of experience in instrumentation throughout the processing industries. They are responsible for the enviable reputation that Taylor is earning around the world . . . a reputation for vision and ingenuity in

working out successful solutions to tricky control problems.

You will see the most advanced models in both pneumatic and electronic instrumentation on display. Many of them will be demonstrated as working models.

Here is an opportunity to tap a storehouse of information on all aspects of process control. Consultation with these men will cost you nothing—it may save you much.

. . .

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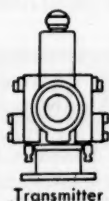
E. B. SUTHERLAND

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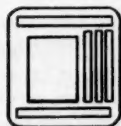
J. G. ZIEGLER

*Taylor Instruments* **MEAN ACCURACY FIRST**

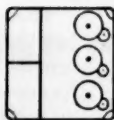
## ELECTRONIC SYSTEMS



Transmitter



Recorder



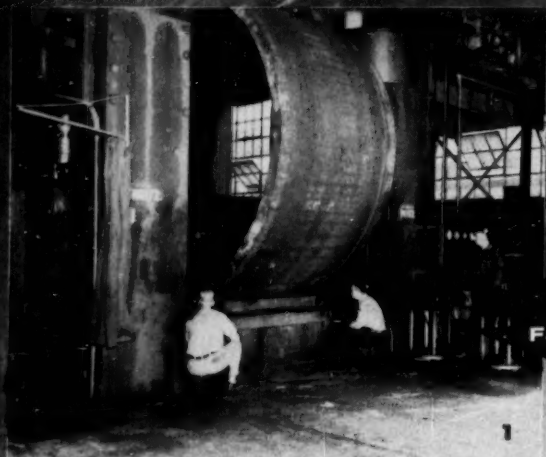
Controller



Valve Positioner



**Electronic  
Process  
Control**



1



2

**CB&I**  
Fabricates



## This is CRAFTSMANSHIP IN STEEL

Precise engineering and EXPERIENCE mark **CB&I** Coordinated Services

Almost 70 years of specialization in the design, engineering, fabrication and erection of steel plate structures will build long and efficient performance life into your next CB&I-built structure. *Here's why:*

**CB&I Engineers.** From first contact with the customer through final testing, CB&I's general engineering staff supplies technical guidance to the CB&I team. Important coordination between fabricating, erection and testing is thus insured.

**CB&I Fabricates.** The finest manufacturing facilities—including X-ray and stress relieving—backed by metallurgical techniques and testing facilities second to none—are maintained in four strategically located and fully equipped fabricating plants.

**CB&I Erects.** Skilled, responsible crews work with up-to-date equipment. Field X-ray and stress relieving equipment, in addition to CB&I-developed welding techniques, are an important part of their trade. Experience in a wide variety of metals, including stainless, nickel, aluminum and clad materials are also part of the service that has earned CB&I a *global* reputation for erecting on a *world-wide* basis.

These coordinated services are what you receive when you contract for a CB&I-built structure. CB&I customers have learned to expect and get top rated performance and maximum service life from *CB&I craftsmanship in steel*. Write our nearest office for details. Ask for the CB&I Bulletins on: *Special Plate Structures* and *CB&I Field Services*.



**CB&I**  
Engineers



- 1 5-in. thick plate for reactor is fabricated at CB&I's Birmingham plant.
- 2 Workman smooths seams on an assembled section.
- 3 X-ray machine checks seam welds. Machines operating at 1,000,000 and 2,000,000 volts are used to completely inspect steel vessels as much as 10 inches thick.
- 4 72-ton top section for reactor-regenerator is lowered into position under supervision of CB&I erection specialist.
- 5 405 STAINLESS STEEL HORTONCLAD® coking chambers were fabricated and erected by CB&I for a Kansas refinery. Stainless is backed by A204 Grade A moly steel.

*Hortonclad®*, developed by CB&I, is a composite metal having an integral and continuous bond produced by a high vacuum bonding process. It is available only in CB&I fabricated tanks, pressure vessels and other clad structures.



P72SCB



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# Refinery licks tough heat exchanger crisis with emergency tube service

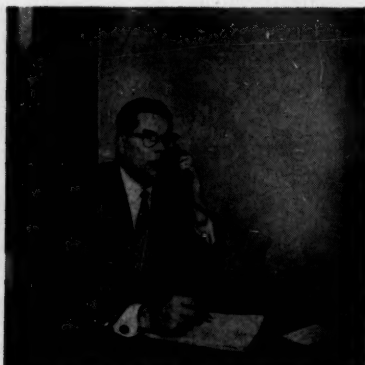
A sudden tube failure at the Pure Oil Company's Refinery in Lemont, Illinois, recently put Bridgeport's condenser tube service to the test. The failure hit on Friday afternoon—just before business slowed down for the week end. Faced with the prospect of costly equipment down time, the refinery called Bridgeport's Chicago office to find out how fast new tubes could be supplied. Here's a round-the-clock story of how the emergency was licked.



**Friday, 2:30 P.M.:** Salesman from Bridgeport's Chicago office learns that Pure Oil needs 900 Admiralty condenser tubes, and fast.



**Friday, 3:00 P.M.:** Salesman contacts our Bridgeport, Connecticut, mill and is informed that order can be delivered to Pure Oil Refinery in one week.



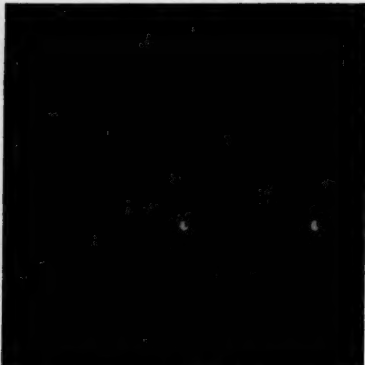
**Friday, 3:30 P.M.:** Sudden change in customer's needs makes immediate delivery of tubes imperative.



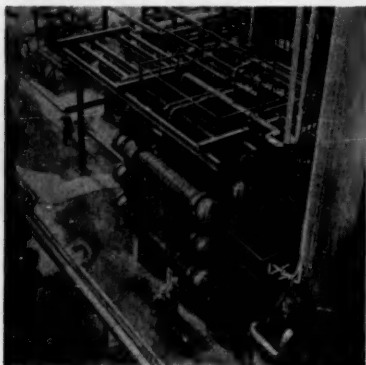
**Friday, 4:15 P.M.:** Chicago office checks through coast to coast network of Bridgeport warehouse stocks. Locates tubes at Beaumont, Texas.



**Friday, 4:30 P.M.:** Special night shift at Beaumont is put on job to cut tubes to special lengths and pack for shipment.



**Saturday, 4:00 A.M.:** Special truck leaves Beaumont, Texas, with order for Pure Oil Refinery in Lemont, Illinois.



**Sunday, 11:30 P.M.:** Truck arrives at Lemont Refinery with 900 Admiralty tubes, ready for repair work to start Monday morning.

While emergencies like this don't happen every day, they do prove dramatically that Bridgeport's customer service can come to the rescue. When we talk about fast service from our network of sales offices and warehouses, we mean it. Let us tell you more about our service on your condenser and heat exchanger tube needs, whether they're emergencies or normal deliveries. Call your nearest Bridgeport Sales Office, or get in touch with us direct.

Write for your free copy of Bridgeport's Condenser and Heat Exchanger Tube Handbook. Address Dept. 5010.



## BRIDGEPORT BRASS COMPANY

Bridgeport 2, Connecticut • Sales Offices in Principal Cities  
*Specialists in Metals from Aluminum to Zirconium*

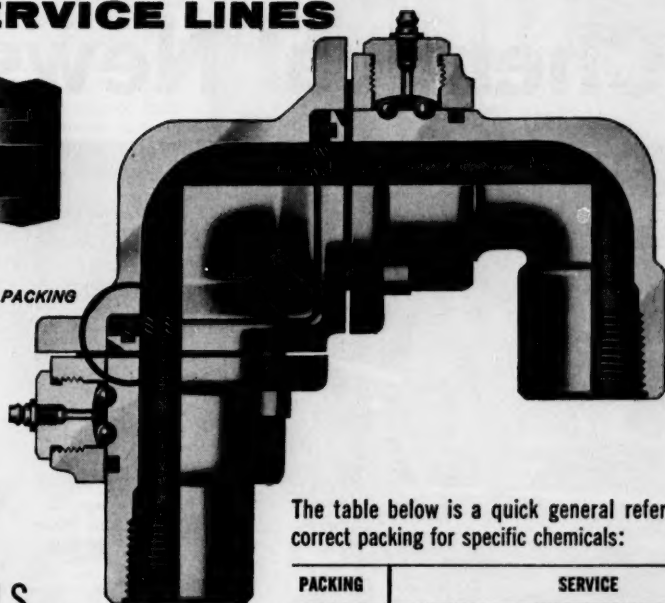
# NEW **CHIKSAN** SWIVEL JOINT

## GIVES SAFE, LASTING FLEXIBILITY TO CHEMICAL SERVICE LINES



VIEW ABOVE SHOWS MOLDED PACKING

VIEW AT RIGHT SHOWS DISC PACKING



**INTERCHANGEABLE  
PACKING FEATURE  
ENABLES DS SERIES  
TO HANDLE A WIDE  
RANGE OF CHEMICALS  
IN SERVICES FROM -65°F  
TO +400°F AT 300 PSI**

The DS Series swivel joint with its broad service range can be a valuable new tool in your process system. Use it in chemical loading of tank car or tank truck, for stress relief in piping subjected to vibration, expansion or settling, or as a steam rotation connection between stationary and revolving equipment. Wherever you use it, you'll find it pays for itself in extended service life.

Using a disc or molded type packing, this swivel joint can be applied to handle steam and any of a wide variety of chemicals processed in your plant. And the split segment feature of the DS Swivel Joint allows replacement of packings without removing the joint from the line.

Buy and apply Chiksan DS Series Swivel Joints for chemical service lines in your plant now. You can select from eight basic styles for full rotation in one, two or three planes. For more information write to Chiksan or fill in the coupon below.



The table below is a quick general reference for the correct packing for specific chemicals:

PACKING	SERVICE
Neoprene	Recommended for alkaline and acid salt solutions and aldehydes such as formaldehyde.
Hycar	These should be used for petroleum derivatives, neutral or slightly acidic salt solutions, dilute acids (Sulfuric to 50%, Hydrochloric and Nitric to 20%), alcohols, glycols, ethers, gases (Oxygen not over 500 psi), and vegetable oils.
Butyl	Recommended for liquid or anhydrous ammonia, gases (except oxygen over 500 psi), ammonia derivatives such as hydrazine and for certain hydraulic fluids such as Pydraul, Skydrol, and Cellulube. It is recommended for acetone and methyl ethyl ketone.
Teflon*	Used for concentrated or fuming acids and other highly oxidizing fluids, esters, aromatics, liquid chlorine, bromine and fluorine if temperature is not excessive.
Asbestos	For use in saturated steam service.
Viton "A"	Recommended for use with concentrated acids, aromatics, liquid chlorine, liquid bromine, chlorine or bromine derivatives, molten sulfur, and carbon disulfide.
Metallic	For extreme services such as hot gas at 600°F., a Stainless Steel metal disc, specially treated to prevent galling, is recommended.

\* R.T.M. DU PONT

CHIKSAN COMPANY, 330 North Pomona Ave., Brea, California  
Please send me copy of Bulletin No. 1258

Name \_\_\_\_\_  
Company \_\_\_\_\_ Title \_\_\_\_\_  
Address \_\_\_\_\_  
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# CHIKSAN

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

#59-46

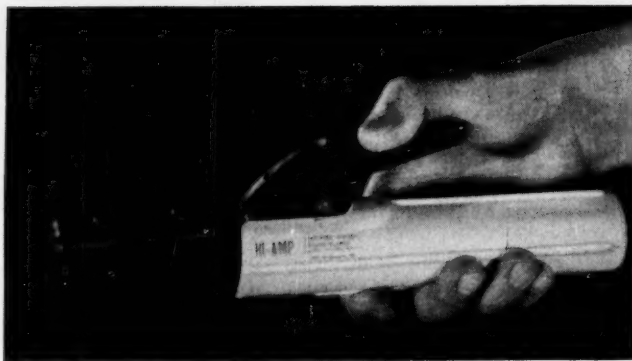
CHIKSAN COMPANY—Brea, California • Chicago 5, Ill. • Newark 2, N.J. • Waco (Division), Houston 24, Texas • Subsidiaries: Chiksan Export Co. • Chiksan of Canada Ltd.

CYANAMID

# Chemical Newsfront



**DUST AND LINT GET THE BRUSH-OFF** from surfaces made from materials treated with CATANAC® SN *Anti-static Agent*. (triangle, left, above.) The outstanding quality of CATANAC SN is its ability to prevent the accumulation of static charge on a wide variety of substances including textiles, plastics, paper, surface coatings, glass and many others. Application is made by spray, brush, wiping, dipping, or, with plastics and resins, by incorporation into the molding composition. Materials containing CATANAC SN will retain their antistatic quality even after soap and water washings. This new antistatic agent is easy to apply and economical. It is ideal for use wherever undesirable static charge is present. (Market Development Department)



**ELECTRODE HOLDERS ARE COLORFULLY INSULATED** with LAMINAC® polyester pre-mix molding compound. Lenco Inc., maker of welding accessories, uses LAMINAC pre-mix in electrode holders because of its high impact strength, excellent flame and heat resistance, low moisture absorption, good electrical properties. The colors, red on tips and trigger, yellow on handle, are molded into the glass-filled LAMINAC for instant identification and safety. Lenco molds the parts in low-pressure compression presses, heated to about 350° F. Because LAMINAC has exceptionally good flow, high molding pressures are not needed to achieve sharp reproduction of mold contours. (Plastics and Resins Division)

**UNIQUE TEST SPEEDS RUBBER'S WAR ON OZONE.** Ozone can attack rubber, and cause such damage as cracked tire walls, severely shortening the life of rubber products. Cyanamid has recently developed an effective laboratory procedure for screening organic compounds as potential antiozonants. In this way, scientists can narrow the search through the many organic compounds to help determine which show enough promise to make actual field testing in rubber worth while. The screening method measures the ability of a compound to suppress reaction of ozone with a model unsaturated hydrocarbon. This latest tool in the war on ozone is already hard at work in Cyanamid's program to develop more effective antiozonants. (Rubber Chemicals Department)



**GREATER DRY STRENGTH FOR PAPER PRODUCTS** is being achieved in scores of mills with ACCOSTRENGTH® RESIN 2386. A synthetic, water soluble polymer, ACCOSTRENGTH 2386 is used for either stock addition or surface application to paper and paperboard. Improved dry strength is evidenced by higher tensile strength, greater folding endurance, added bursting strength and increased inter-fiber bonding and wax pick. ACCOSTRENGTH 2386 has unique ability to bring about greater dry strength with little change in bulk or porosity and thus proves highly valuable in the manufacture of printing papers and similar grades. (Paper Chemicals Department)

**CYANAMID**

AMERICAN CYANAMID COMPANY  
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

**INSECTS DROP LIKE FLIES.** Currently, over 100 formulators are using Cyanamid's MALATHION in insecticides. A unique phosphorus-sulfur containing compound, MALATHION harms neither man nor his animal friends. Yet it brings death, swift and sure, to bugs and insect pests by attacking vital nerve centers in their bodies. Malathion-base insecticides are used to protect fruits, vegetables, ornamentals, livestock and household pets. Its low toxicity to man and animals makes it one of the safest insecticides in the market today. (Agricultural Division)



For further information on products in this advertisement wire, phone—  
or mail this coupon to:

AMERICAN CYANAMID COMPANY  
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Please send me additional information

- ☐ CATANAC® SN Antistatic Agent
- ☐ LAMINAC® polyester pre-mix molding compound
- ☐ ACCOSTRENGTH® RESIN 2386
- ☐ MALATHION
- ☐ ANTIOZONANTS

Name \_\_\_\_\_

Company \_\_\_\_\_ Position or Title \_\_\_\_\_

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# Now Rent a Laboratory Homogenizer

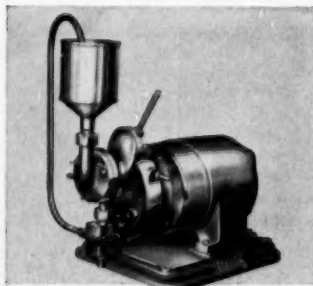


## For Only \$75<sup>00</sup> per Month

...and see for yourself how  
**Gaulin Particle Control**  
improves product quality and reduces costs

Now, for a few dollars per day, you can have a laboratory homogenizer in your plant to explore the advantages of Gaulin Particle control on your product . . . to produce superior dispersions, emulsions or blend. No special skills are required to operate the machine. It is quickly and easily disassembled for inspection and cleaning.

Maximum capacity is 15 gph; minimum processable sample — 1 pint; pressures to 8000 psi continuous, 10,000 psi intermittent.



Gaulin RE® Two-Stage colloid Mill — Model 2A — is available for processing quantities as small as 8 ounces, and is invaluable for research, laboratory or pilot plant applications. Also available on rental basis.

Remember, the rental cost is applicable against the price of the machine.

Write for more information and bulletins on the Gaulin Laboratory Homogenizer LH-55, Sub-Micron Disperser SMD-55, Homogenizers H-55.



71 Gordon Street, Everett 49, Mass.

World's largest manufacturer of stainless steel reciprocating, rotary, pressure exchange pumps, dispersers, homogenizers and colloid mills.

## Ask GTA...

Gaulin Technical Assistance — for data on the complete Gaulin line: Homogenizers, Colloid Mills, Submicron Disperser, Triplex High Pressure Pumps and HX Pumps. Get GTA from your nearest Manton-Gaulin Representative . . .

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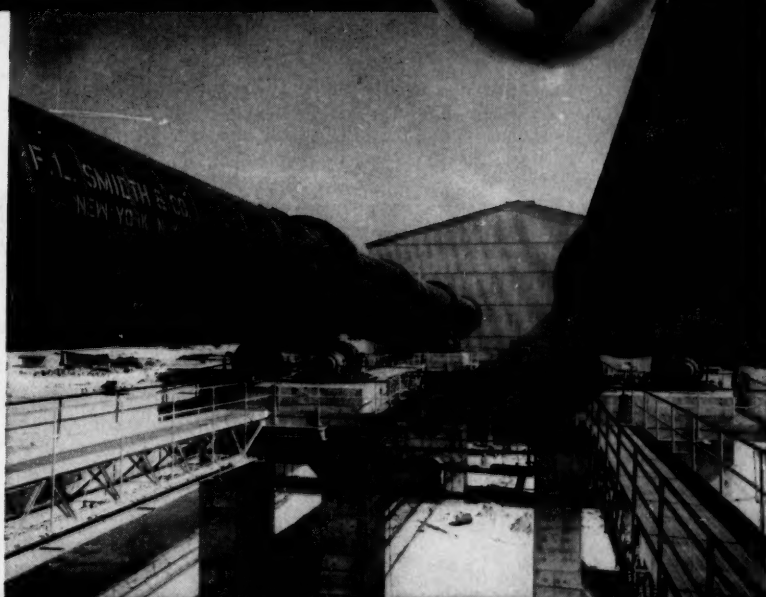
# SMIDTH



## rotary kilns

For sintering, nodulizing, calcining, desulphurizing, oxidizing and reducing roasting. Coolers, precoolers, preheaters, recuperators.

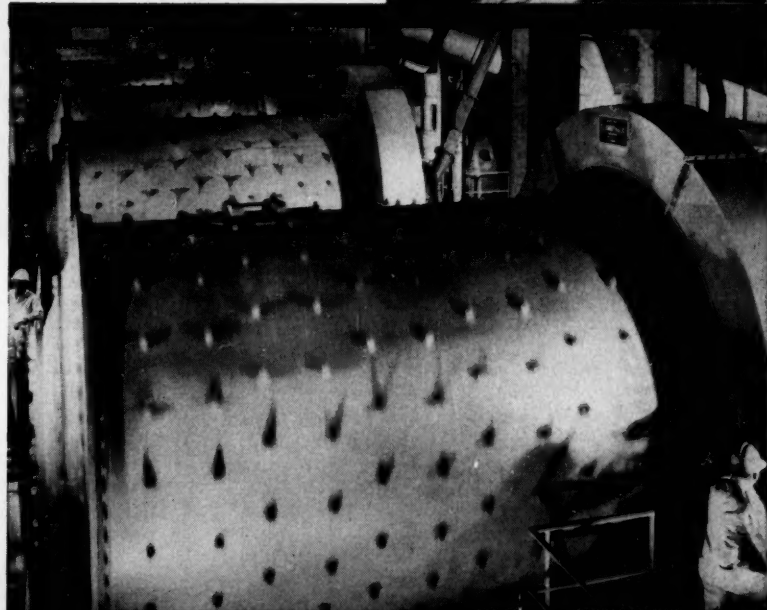
Auxiliary equipment for Rotary Kiln Plants.



## grinding mills

Ball mills, tube mills and multicompartment mills—open or closed circuit—wet or dry grinding. Also airswept for grinding and drying.

Over 1250 Smidth Rotary Kilns and over 5000 Grinding Mills supplied all over the world.



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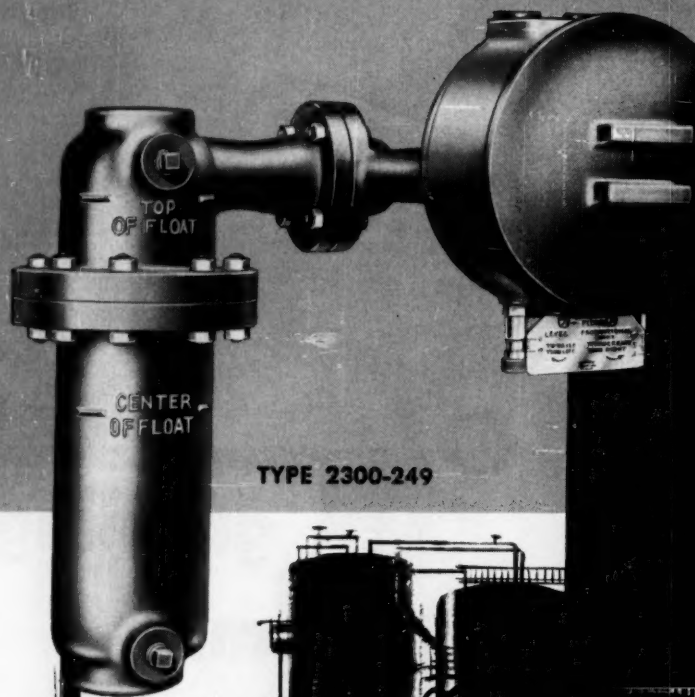
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# Choose Electronic or But Choose the



TYPE 2300-249

THE  
CONTROLLERS  
THAT HANDLE  
ALL YOUR  
LIQUID LEVEL  
PROBLEMS



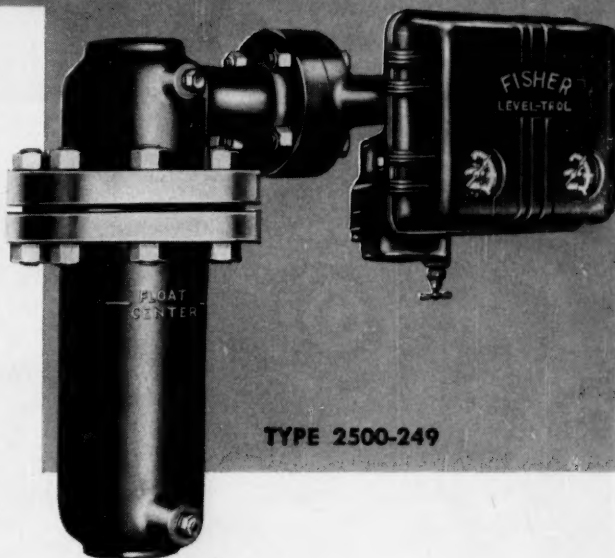
IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD...CHANCES ARE IT'S CONTROLLED BY...

# Choose Pneumatic **FISHER LEVEL-TROL®**

Using essentially the same displacement float assembly and other components that have made the Level-Trol so popular in the process industries, Fisher can now provide the Level-Trol with either a pneumatic or an electronic pilot. The same style of Level-Trol mounting and displacement floats in sizes up to 120" can be supplied for either pilot.

**Type 2300-249 Electronic Level-Trol:** Explosion-proof design and external adjustments for proportional band and liquid level set point make the Fisher Electronic Level-Trol ideal for use in hazardous locations. Delivers a proportional 1 to 5 milliamperes dc signal through 3000 ohm load. Has plug-in converter with printed circuit.

**Type 2500-249 Level-Trol:** Highly flexible! Can be pneumatically operated with a wide variety of pilots. Handles practically any liquid level, interface level or specific gravity control or indication problem.



SINCE 1880

## **FISHER GOVERNOR COMPANY**

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BUTTERFLY VALVE DIVISION: CONTINENTAL EQUIPMENT CO., CORAOPOLIS, PENNSYLVANIA

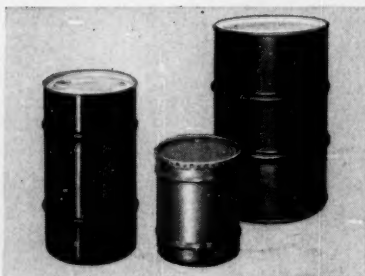
# ELECTRUNITE "Dekoron- E.M.T. resists corrosion... moisture



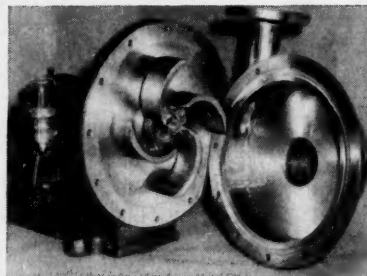
## REPUBLIC PRODUCTS SERVING THE CHEMICAL INDUSTRIES



**REPUBLIC WEDGE-LOCK® STORAGE UNITS** are designed for heavyweight storage—easy to load and unload from either side. Wedge-Lock construction features a post that will not bend, a reinforced shelf that does not sag, and a concealed sway-proof joint. Unlimited shelf arrangement. Send coupon today for more information.



**PROTECT YOUR PRODUCT WITH REPUBLIC STEEL CONTAINERS.** Republic's full line of steel containers, available in a wide range of types, sizes, and finishes, helps you extend product quality control from your shipping floor to point of use. For complete information, send for Republic's container catalog. Write today.



**TITANIUM ASSURES YEARS OF ADDED LIFE** to processing equipment, such as this centrifugal pump used in severe corrosive applications. Titanium is even more corrosive-resistant than stainless steel. Titanium equipment is easy to handle, is as strong as steel, yet weighs only 56% as much. Write today for additional information.

# *Coated"* chemical action



REPUBLIC ELECTRUNITE "Dekorón-Coated" E.M.T. outlasted standard galvanized carbon steel conduit ten to one over a six-year period at the Charmin Paper Products Company, Green Bay, Wisconsin. Major maintenance problems were eliminated.

## REPUBLIC "DEKORON-COATED" E. M. T. OUTLASTS STANDARD CONDUIT 10 TO 1

Republic ELECTRUNITE® "Dekorón®-Coated" E.M.T. protects vital wiring systems, reduces costly electrical raceway replacement-maintenance costs.

Where fumes, gases, steam, other corrosive materials destroy standard conduit in a matter of months, "Dekorón-Coated" E.M.T. is still in service seven, eight, ten years and more.

ELECTRUNITE, the steel raceway core of "Dekorón-Coated" E.M.T., is produced from highest quality flat-rolled, open-hearth steel, made in Republic's own mills to Republic's rigid manufacturing specifications.

A armor-tough, corrosion-proof polyethylene is applied over the galvanized finish. Every length is fully protected from end-to-end. Couplings and fittings can be protected by plastic tape.

"Dekorón-Coated" E.M.T. is easy to cut, easy to bend, easy to install. It is available in a full range of E.M.T. sizes, and rigid conduit sizes, and meets the requirements of electrical codes and specifications.

To learn more about the installation advantages and economies of Republic "Dekorón-Coated" E.M.T., and Rigid Steel Conduit, call your Republic representative. Or, mail coupon below.

# REPUBLIC STEEL



*World's Widest Range  
of Standard Steels and  
Steel Products*

### REPUBLIC STEEL CORPORATION

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Please send information on the following Republic products:

- ☐ "Dekorón-Coated" E.M.T. ☐ Containers  
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## Calling in equipment representatives on your processing job?



Be sure one of them  
is from  
**AMERICAN-Standard**  
Industrial Division



You benefit by discussing equipment-selection with an engineer. American-Standard\* Industrial Division is engineer-staffed from brass to branches. Combining three American-Standard divisions—American Blower, Ross Heat Exchanger, Kewanee Boiler—this new organization offers *one-source responsibility* for quality

and performance in equipment designed, engineered, and manufactured to work together. There are offices in all principal cities; contact the one nearest you. American-Standard Industrial Division, Detroit 32, Michigan. In Canada: American-Standard Products (Canada) Limited, Toronto, Ontario.



Firebox, scotch-type steel boilers and package units for heat, power, steam.

Heat exchangers, condensers, and feed-water heaters for every requirement.

Fluid drives for stepless, adjustable-speed control of driven machinery.



\*AMERICAN-Standard and Standard® are trademarks of American Radiator & Standard Sanitary Corporation.

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INDUSTRIAL DIVISION

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# 13

## CHOICES

for improved solids deliquescence

### 4 sizes of CONICAL SCREEN CENTRIFUGE



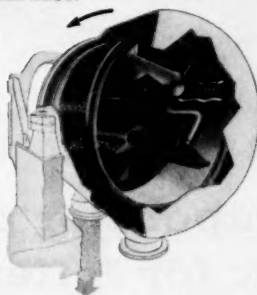
The Sharples Continuous Dehydrator is especially applicable for high concentrations of medium-to-coarse crystalline solids and fibrous pulps.

By changing the size of the openings in the perforate plate and by changing the rotational speed, varying degrees of liquid clarity and/or solids dryness can be achieved as desired. Available in four sizes, with solids handling capacity ranging from a few hundred lbs./hr. to 50 tons or more/hr.—e.g., on synthetic ammonium sulphate the Model 510 will dewater 50 tons/hr. or more to 1% or less residual moisture.

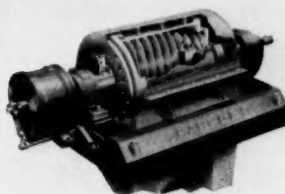
Write for Data Sheet on the Sharples Continuous Dehydrator.

### 3 sizes of AUTOMATIC PERFORATE BASKET CENTRIFUGE

The Sharples Super-D-Hydrator has an excellent performance record on materials with low drain rates, where product purity is of critical importance. By applying high centrifugal force (to 1250 x g), a unit load of crystals can be handled very rapidly; with the thin crystal layer, there is little filtration resistance, and crystals quickly give up mother liquor. Designed for multiple rinsing for super purity such as is demanded by the polyolefins. Capacities range from a few hundred lbs./hr. to 25 tons/hr., depending on characteristics of slurry. Available for pressure operation. Write for Bulletin 1286.



### 6 sizes of SOLID BOWL CONTINUOUS CENTRIFUGE



The Sharples Super-D-Canter is a high speed clarifier or classifier, applicable to an extremely wide range of both amorphous and crystalline solids ranging from relatively large size particles down to those a few microns in size.

Solids handling capacity ranges from as little as a few lbs./hr. up to 10-15 tons/hr. and liquid handling capacity ranges from a few gal./hr. to several hundred gal./min.

For example—in the classification of kaolin clay slip a P-7000 Super-D-Canter delivers 16 to 18 tons/hr. of classified product in the liquid discharge (80%-90% 2 microns).

Models are available for operation at pressures to 150 psi. Write for Bulletin 1254.

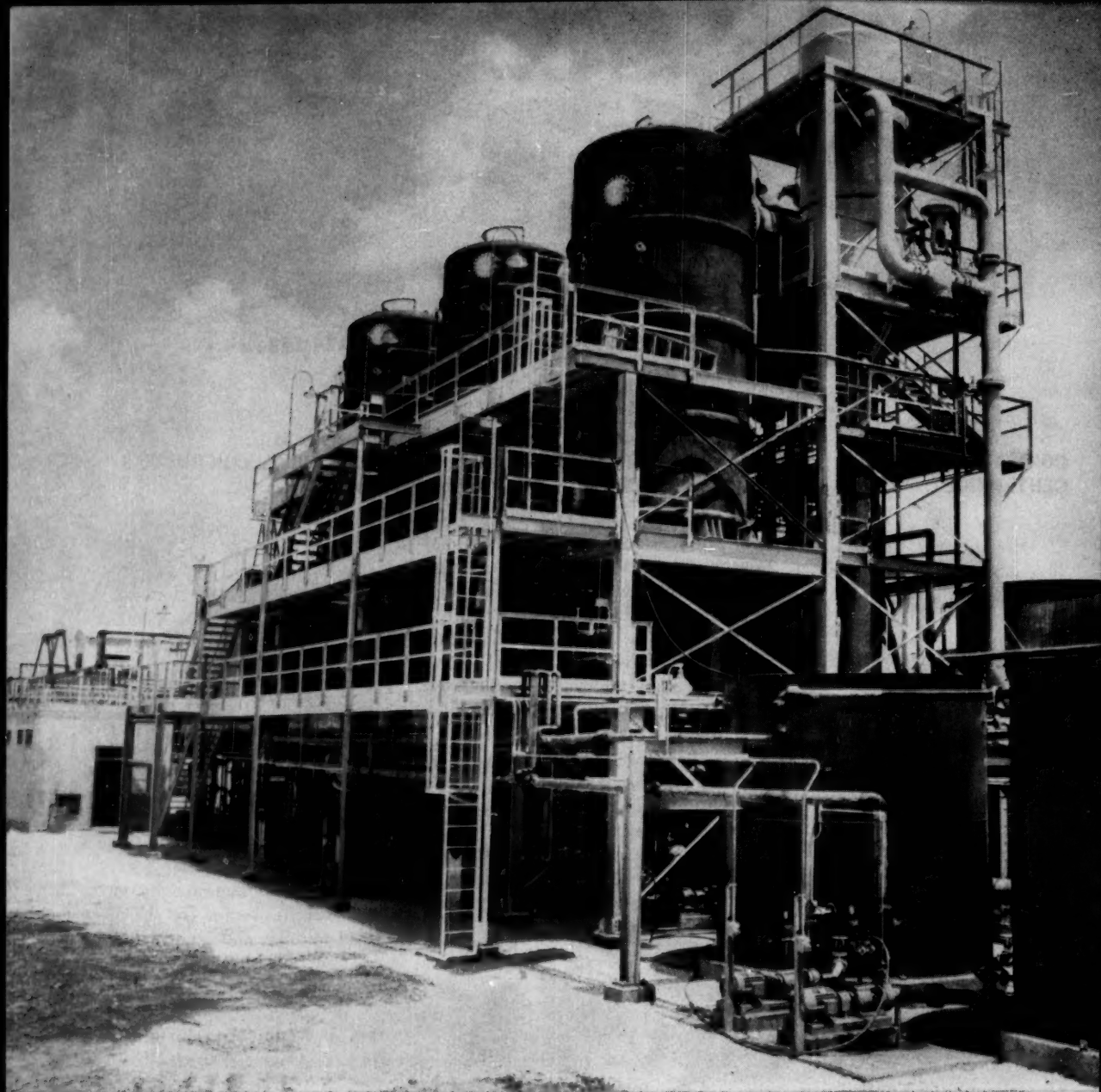
*Whether You are Deliquescenting a Super-Pure Hydrocarbon, Dehydrating Ammonium Sulphate, Dewatering Corn Fibre . . . Producing Polyolefins, Removing Suspended Solids to Clarify a Liquid . . . or Any of Hundreds of Similar Operations . . . Sharples has the type and size of modern centrifuge to do the job efficiently at low cost. That's why it will pay you to get in touch with the company that has them all, and can recommend the one best suited to your needs . . .*



# THE SHARPLES CORPORATION

Centrifugal and Process Engineers

2300 WESTMORELAND STREET / PHILADELPHIA 40, PENNSYLVANIA  
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## Giant Bufllovak evaporator produces 50% and 73% caustic for Jefferson Chemical

At Port Neches, Texas, this 188-ton evaporator for electrolytic cell liquor goes on stream. It's a triple effect operation—concentrating to 50%, recovering the salt, cooling the caustic to remove the salt, and then concentrating as much as half the caustic to 73%.

### More caustic is concentrated in Bufllovak evaporators than any other kind

Bufllovak installations all over the world total 3,000 tons of caustic production per day on a 100% NaOH basis. Units are custom designed and built in single, double, and

triple effects, and range in capacity from 10 to 880 tons per day. Bufllovak's complete line of evaporators provides cost cutting answers to a wide range of processes.

### Bring your own processing problems to Bufllovak

A completely equipped Customer Service Lab is at your service to pre-test your product or process. Skilled engineers will study your operation and make recommendations based on test results, or on your own specifications. Write for Catalog 372 on Evaporators, or Catalog 381 on the Customer Service Laboratory.



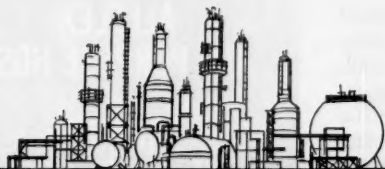
### BLAW-KNOX COMPANY

*Bufllovak Equipment Division*

1551 Fillmore Avenue, Buffalo 11, New York

## For Spray and Impact-Resistant Safety — AO 710 SPLASH GOGGLE

Developed in conjunction with a leading chemical company. Ample indirect ventilation prevents build ups of high humidity, eliminates fogging. Tests show this goggle twice as fog-resistant as similar goggles. Wide angle vision for better seeing on job and greater safety. FITS OVER ALL TYPES OF PERSONAL AND SAFETY R GLASSES. Frame molded from non-irritating, clear vinylite. Lenses are impact-resistant acetate (clear or green) and conform to highest safety and optical standards. All parts replaceable — goggle is easy to clean and sterilize.



## This Compact AO Pocket Respirator **FITS EVERYBODY!**

*Half the weight* of competitive respirators . . . economical . . . and highly efficient against dusts, mists, organic vapors, acid gases and ammonia, this mouthpiece type respirator fills a real need in industry. Large chemical companies have standardized on it. Constructed without a mask,

it is particularly desirable in hot climates. Mouthpiece of *vinyl* cannot be destroyed by biting. The respirator can take punishing usage without harm. Easily sterilized . . . complete valve system . . . low breathing resistance . . . interchangeable filter cartridges.

**YOUR NEAREST AO SAFETY PRODUCTS REPRESENTATIVE CAN SUPPLY YOU**

*Always insist on*

**AO** Trademarked Safety Products

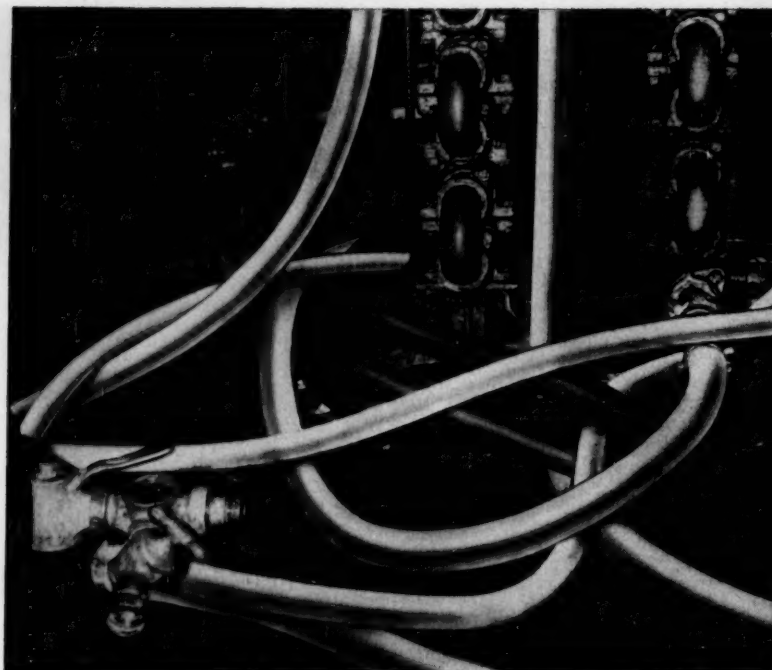
American Optical

COMPANY

SAFETY PRODUCTS DIVISION

SOUTHBIDGE, MASSACHUSETTS

*Safety Service Centers in Principal Cities*



## **R/M HOSE**

### ***Engineered for Chemical Processing***

Engineered features of Raybestos-Manhattan hose for the chemical industry increase hose service life for every job requirement. Condor Acid Hose, for example, can handle practically all inorganic acids and salts up to 150° F. It is available with special tubes of rubber, neoprene, Butyl or Hypalon to withstand a wide variety of active chemicals. Super-Master BW Hose with woven wire reinforcement is practically burst-proof, ideal for handling steam, air and water under high pressures. R/M Teflon\* Lined Hose assures complete resistance to most active corrosive and contaminating solutions, prevents caking of hose lines. Raybestos-Manhattan also manufactures special types of oil-proof hose for petro-chemical processing.

For general service at the chemical plant, Allflex is light, strong, and flexible as a rope . . . the easiest handling all-purpose hose made for use with air, water, oil and gases—even mild chemicals.

Where corrosion, wear, or expansion are problems with metal pipe, use Condor Flexible Rubber Pipe that outlasts iron or steel. R/M Rubber Expansion Joints are engineered to prevent stresses of expansion, misalignment, and insulate vibration.

For every application in the chemical industry, there's an R/M hose or Condor Flexible Rubber Pipe to do a better job, longer . . . give you "More Use per Dollar." Discuss your requirements with an R/M representative.

**CONDOR ACID HOSE**

**SUPER-MASTER  
BW HOSE**

**for Steam, Water, Air**

**R/M TEFLON\* LINED  
HOSE**

**ALLFLEX  
ALL PURPOSE HOSE**

**PARANITE  
OIL-PROOF HOSE**

**CONDOR FLEXIBLE  
RUBBER PIPE**

**R/M EXPANSION  
JOINTS**

*"More Use per Dollar"*

WRITE FOR BULLETINS

\*Teflon—A Dupont trademark

RM-905

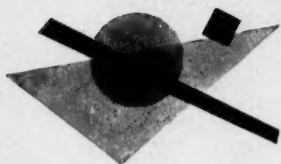
**BELTS • HOSE • ROLL COVERINGS • TANK LININGS • INDUSTRIAL RUBBER SPECIALTIES**

**MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY**

**RAYBESTOS-MANHATTAN, INC.**

Other R/M products: Abrasive and Diamond Wheels • Brake Blocks and Linings • Clutch Facings • Asbestos Textiles • Mechanical Packings • Engineered Plastics • Sintered Metal Products • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls





# MODERNIZING WITH NEW EQUIPMENT?




what will the **REAL** cost be?

## REAL COST =




CAPITAL COST  
INSTALLATION COST  
AVOIDABLE WASTE  
MAINTENANCE  
DELAYED PRODUCTION

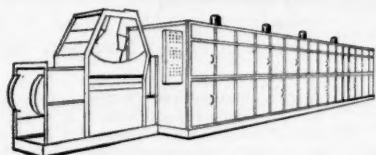
The purchase price can be the least of these over the years you will operate the equipment. PROCTOR users agree that the comparison of real costs often looks like this.

### PROCTOR EQUIPMENT

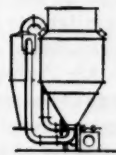
OVERALL COST	maintenance	
	cost of set-up time	
	capital purchase price	

### OTHER EQUIPMENT

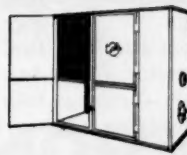
maintenance	
cost of set-up time	
capital purchase price	



CONVEYOR DRYERS



SPRAY DRYERS



TRAY DRYERS



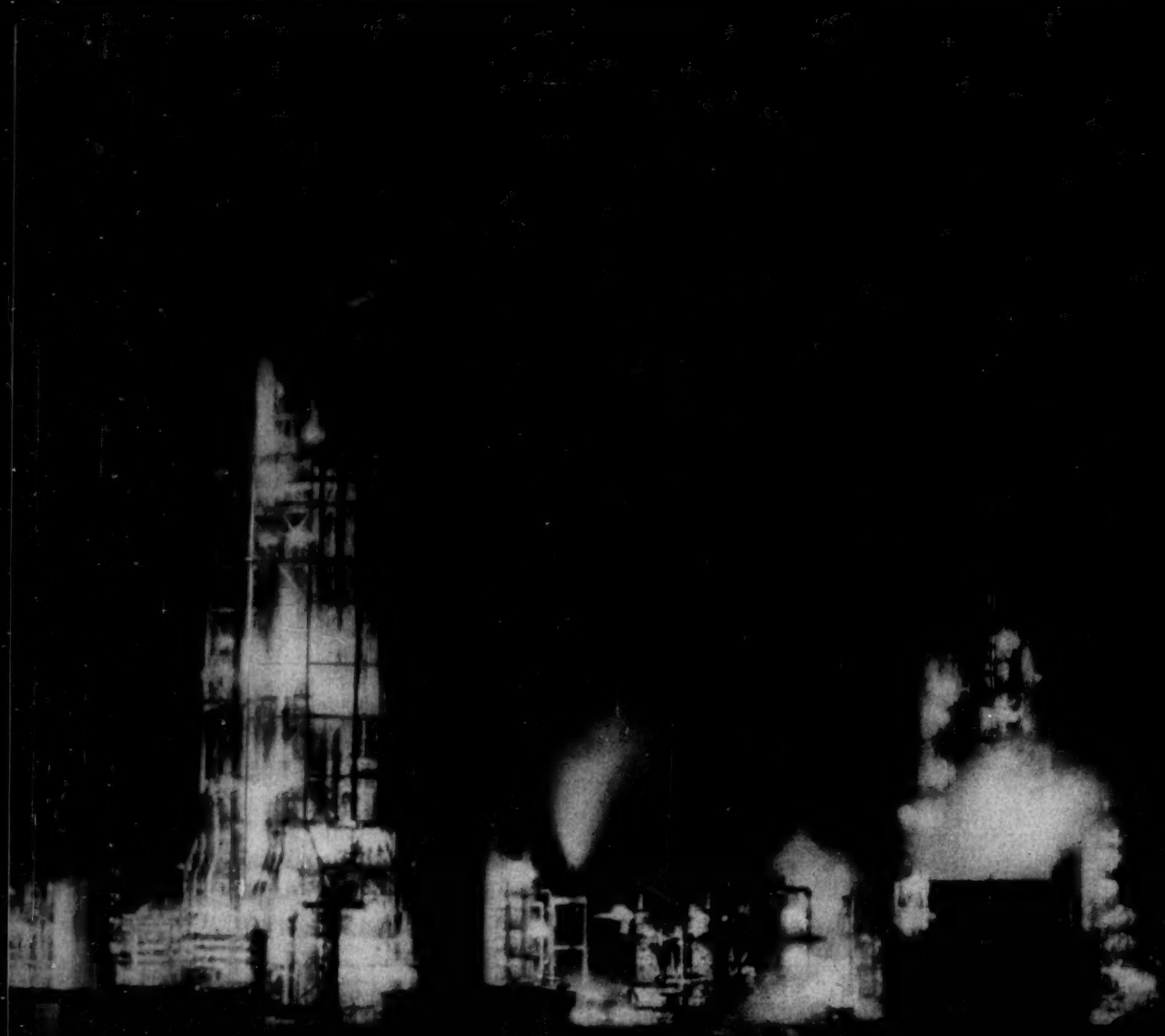
TRUCK DRYERS

Proctor & Schwartz will be happy to show you how buying Proctor equipment will cost you less.



See our insert in Chemical Engineering Catalog.

**PROCTOR & SCHWARTZ, INC.**  
PHILADELPHIA 20, PA.



REPLACE STILL CONVECTION BANKS

## WITH A **LJUNGSTROM®** AIR PREHEATER

You can make major economies in the refining of corrosive crudes, or in any refining that involves very high temperatures, by replacing still convection banks with a Ljungstrom Air Preheater. This is how.

The radiant section of your still, operating with an Air Preheater, can deliver as much throughput (and possibly more) as was formerly possible using convection banks. And with an Air Preheater the oil tubes get the maximum amount of heat without the expensive heat- and corrosion-resistant alloys sometimes required for convection banks.

In addition, an Air Preheater provides other economies that you just don't get with convection banks. For example, an Air Preheater can cut fuel costs by 20%. It will promote high equipment availability by drastically cutting formation of slag and deposits. And an Air Preheater can take full advantage of the most modern fuel-burning equipment to give you much closer control of temperature—close enough to boost average

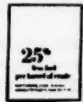
product ratings as much as two octane numbers.

These extra savings can be almost pure profit, because you will probably save enough by eliminating or reducing convection banks to pay the cost of an Air Preheater installation.

*Here's documented evidence. One company's fuel savings with a Ljungstrom Air Preheater are factually described in a published magazine article by O. F. Campbell. A reprint of this case history is yours free. Simply write to Air Preheater Corp.*

### THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.





*Five large mounds of solar salt, harvested from huge ponds of salt water at a Morton plant in the West, await shipment to industry.*

## Only Morton offers salt service to industry everywhere in America

Morton, the only nation-wide salt company, has salt sources, sales offices and warehouses from coast to coast. This means Morton can offer you complete salt service whether you have just one plant or several plants in different states.

Morton produces, refines and delivers nearly 100 different grades of salt to industry for 14,000 different uses. This means you can get expert, *impartial* advice on which grades will do the best job for you.

Morton has two or more sources for any grade of salt you might use. This means Morton is better equipped to make delivery from alternate plants, even under adverse conditions that might otherwise endanger the continuous operation of your plant.

Morton delivers salt by boat, barge, truck and rail. This means you can get fast delivery on a bag to thousands of tons, anywhere in the country.

Morton sales representatives are backed by the services of their own ultra-modern salt research laboratory—the most complete laboratory of its kind in the world. This means you can get complete technical assistance on any problem relating to salt. This service help alone may be worth thousands of dollars to you every year.

▲ Salt Sources    ▲ Warehouses    ▲ Sales Offices

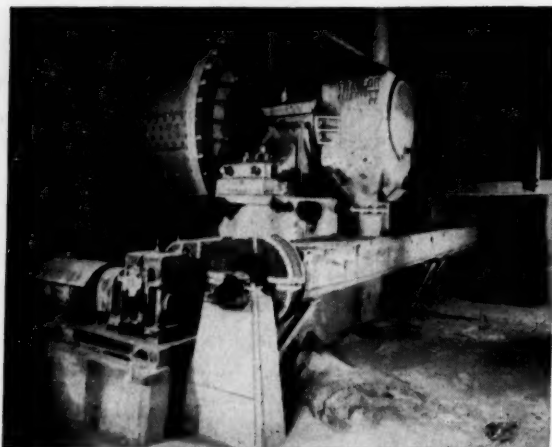


**MORTON SALT**  
**COMPANY**  
INDUSTRIAL DIVISION

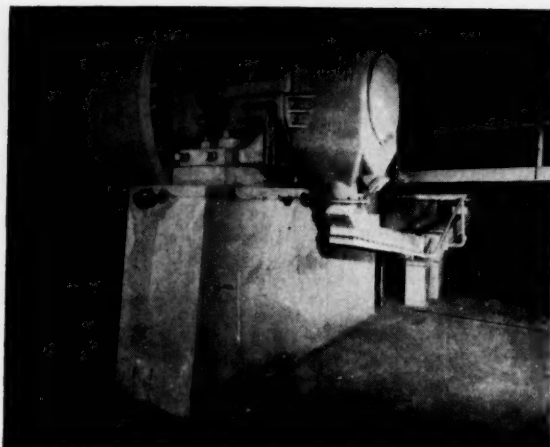


110 N. Wacker Drive, Chicago 6, Illinois, Telephone FI 6-1300

## The Arithmetic of Materials Handling



**BEFORE:** Dirt, noise and mechanical breakdown were constant problems in this cement plant, where two mechanical conveyors were used to collect raw materials. A 5 h.p. motor driving auxiliary equipment wasted valuable space and power, required frequent maintenance. Spillage clean-up wasted costly man-hours.



**AFTER:** Clean, simple, quiet. Notice the difference two 8" F-H Airslide® fluidizing conveyors have made. No dangerous moving parts. Nothing to lubricate. Auxiliary equipment and foundations are gone. Power needs are now only 1/8 of previous needs. Fluidizing saves wear and maintenance.

## **AIRSLIDE®** Fluidizing Conveyor minimizes material loss . . . maintenance . . . moving parts

If you are now handling dry, pulverized materials, the F-H Airslide Fluidizing Conveyor can help you stop noise, and air-pollution, as well as speed flow and reduce maintenance cost.

### **Simplicity Itself**

F-H Airslides fluidize dry, pulverized materials with low pressure air.

These materials literally flow at high speed, down the inclined conveyor. Power requirements are small.

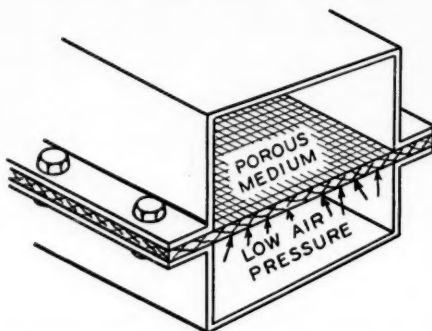
### **Flexibility, Low Cost**

For unlimited applications, Airslide conveyors take up little space, and can be used singly and in combination with other Fuller pneumatic conveying systems. The movement of fluidized material can be around corners, between floors, through walls—nearly any conveying distance.

### **Better Housekeeping**

Can Fuller conveying systems help eliminate your housekeeping problems—cut your maintenance and handling costs? Write today, outlining your problem in handling dry, finely-divided materials. Fuller will gladly make appropriate recommendations.

## **"Pulverized Materials Flow Like Water!"**



**AIRSLIDE PRINCIPLE:** Porous supporting medium divides conveyor section into two "compartments". Dry material flows down inclined conveyor, fluidized by low-pressure air entering beneath porous medium.



4483  
FH 99

**"See Chemical Engineering Catalog for details and specifications".**

### **FULLER COMPANY**

**134 Bridge St., Catasauqua, Pa.**

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Wherever you find chemical processes in use in industry—and the range is immense, from photographic film to rocket fuels—the chemical engineer is always the common buying-specifying focus. He is responsible for profitable application of the technology that ties this industrial complex into one huge marketplace for equipment, raw materials and services. Sell him first, and you've sold the CPI. And make sure you keep him sold.

The one sure way of getting your message to this man is through **CHEMICAL ENGINEERING**—preferred by a 3 to 1 margin among chemical engineers in all functions, in all industries. They get it every other Monday, read from cover to cover. 1958 Starch "Noted" scores were up 11.3%, "Read Most" score jumped 28.7%, inquiries were 15.5% above 1957's monthly issues. **CHEMICAL ENGINEERING**, McGraw-Hill Building, New York 36, N. Y. ☉ ☉



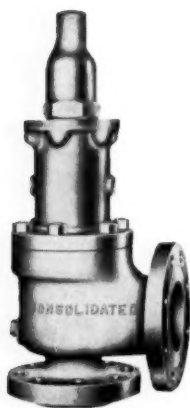
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## **CORRUGATED SLEEVE**

**shields working parts**

A durable, two-ply stainless steel Sealing Bellows in Consolidated Safety Relief Valves isolates contaminants, corrosion or viscous fluids from the working parts. The Bellows is balanced with the seating surface. Capacity is less affected by variable back pressure, so you can use smaller discharge piping and reduce the cost of pressure-relieving systems.



Consolidated Safety Relief Valve with Sealing Bellows. Type 1900-30 Series, Sizes: 1½" x 2" to 8" x 10".

Full-rated relieving capacity is certain at all positions of the single blowdown adjusting ring because a fixed maximum secondary orifice provides full lift at 10% overpressure. Even with superimposed back pressure in the relieving system, valve action is consistently positive.

Protection of working parts is but one of many reasons why Bellows Type Consolidated Safety Relief Valves assure absolute protection for personnel and facilities. Write for details, including facts about the Standard valve that you can convert to the Bellows type in your own shop. Ask for Catalog 1900.



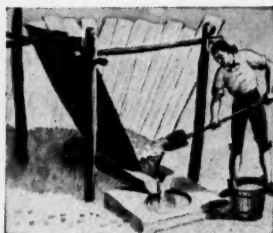
### **CONSOLIDATED SAFETY RELIEF VALVES**

**A product of**

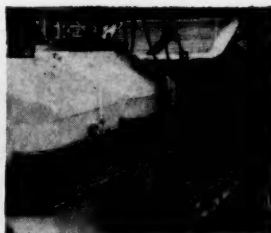
**MANNING, MAXWELL & MOORE, INC.**

*Consolidated Ashcroft Hancock Division • Tulsa, Oklahoma*

*In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*



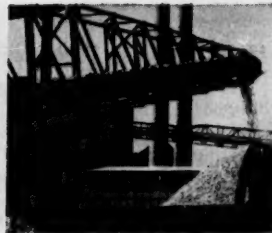
History of caustic soda



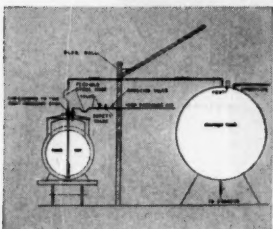
How it's made



Best methods of shipping



Materials for various processes



Unloading procedures



Safety measures



Methods of analysis

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## 56-PAGE REFERENCE BOOK ON caustic soda

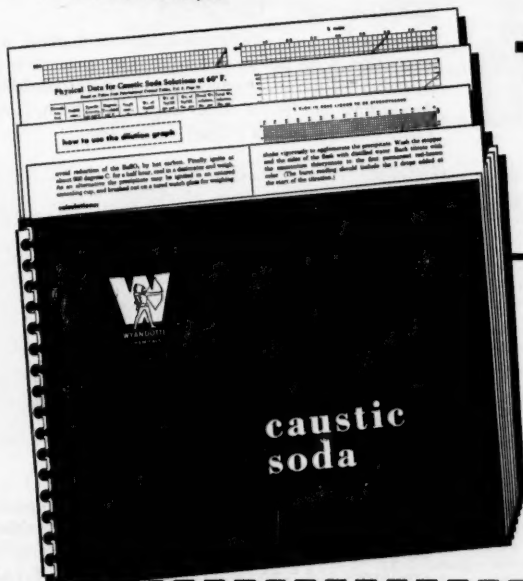
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grades . . . pump and air methods of unloading . . . diluting 74% liquid . . . dissolving anhydrous grades . . . materials of construction . . . safety reminders on unloading and waste disposal . . . chemical reactions . . . analytical methods. All this and more — along with an appendix chock full of helpful graphs and tables.

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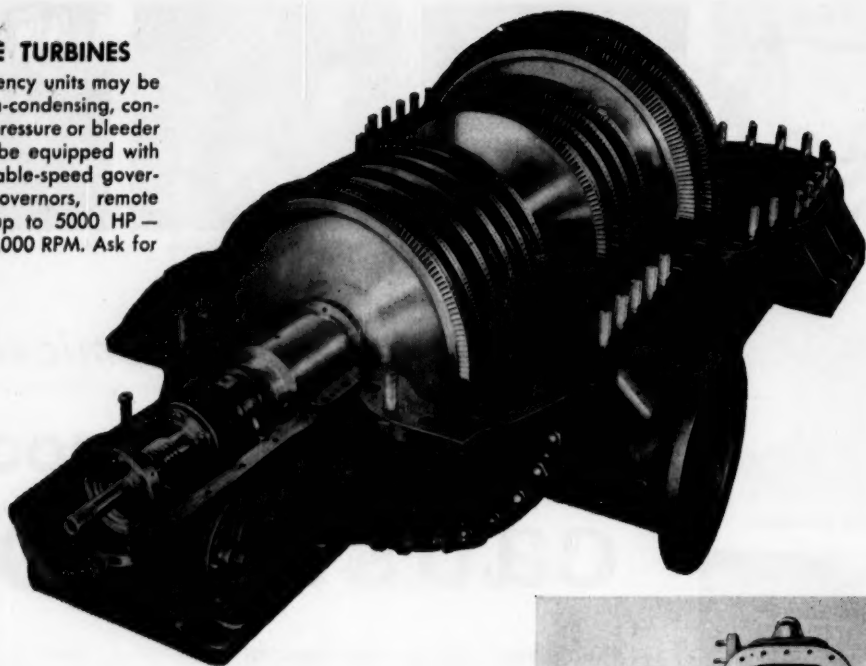
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### MULTI-STAGE TURBINES

These high-efficiency units may be designed for non-condensing, condensing, mixed pressure or bleeder operation. Can be equipped with constant or variable-speed governors, special governors, remote controls. Sizes up to 5000 HP — Speeds up to 10,000 RPM. Ask for Bulletin S-146.



## There's a **Terry turbine** for every mechanical-drive requirement

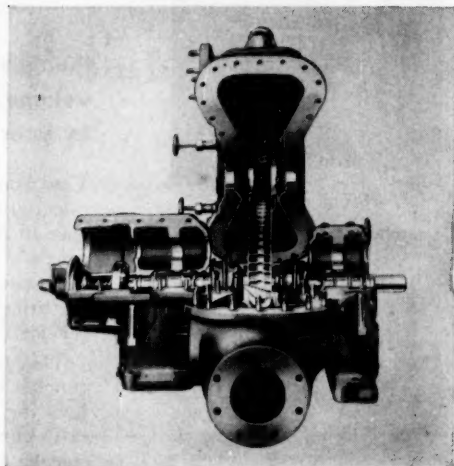
The designs for Terry turbines are based on more than 50 years of successful experience in the manufacture of turbine drives *exclusively*. This specialization has resulted in Terry becoming one of the *leading producers* of mechanical-drive turbines in sizes up to 5,000 horsepower.

There are three basic reasons why Terry has been able to maintain this position of leadership: (1) a thorough knowledge of the requirements of mechanical-drive turbines, (2) a willingness to build "a little something extra" into each machine to assure trouble-free operation, and (3) an acknowledgement of the company's responsibility to stand behind the performance of every turbine sold.

These are also the reasons why you should consider a Terry turbine for your next mechanical drive. In the meantime, send for bulletins describing any of the types of machines illustrated.

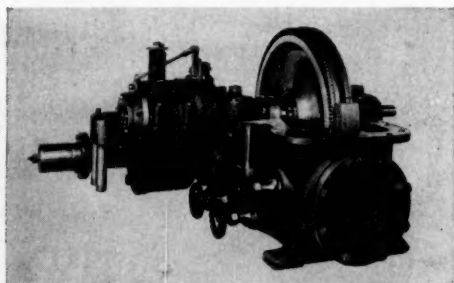
**THE TERRY STEAM TURBINE COMPANY**  
TERRY SQUARE, HARTFORD 1, CONN.

# TERRY



### SOLID-WHEEL TURBINES

Famous for sure dependability and ease of inspection. Can be started cold — no preliminary warming required. Available in vertical designs depending on frame size. Capacities from 5 to 2,000 HP. Described in Bulletin S-116.



### AXIAL-FLOW IMPULSE TURBINES

Built with one, two or three rows of high-grade stainless steel blading, these turbines combine efficiency with durability. Available in designs for moderate and high steam pressure. Bulletin S-143.



*Nationwide stocks give you prompt delivery...*

## on **CF&I-CLAYMONT HEADS**

This giant steelman — the Image of CF&I — represents service for CF&I customers coast to coast. One example of this service is the inventory of Claymont Steel Head stocks maintained at strategically-located CF&I warehouses.

Elliptical Heads are stocked at Houston • Los Angeles • San Leandro, Calif. • Tulsa

Inside Diameters—24" to 120"  
Specifications—A-285-C and A-212-B Firebox Steels

ASME and Standard Flanged and Dished Heads are stocked at Chicago • Claymont, Del. • Houston • Tulsa

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Specifications — ASTM A-285-C Flange and Firebox Steel; Hot Pressing Steel (for Standard Heads only)

Fittings are stocked at Chicago • Claymont, Del. • Houston • Tulsa

Manhole and Handhole Fittings • Elliptical Manhole Rings for Low Pressure Vessels • Storage Tank Manhole Frames and Covers

Claymont is completely equipped to produce spun or pressed heads in diameters from 9" to 19"... in gages from 3/16" to 6"... in all shapes and a complete range of ferrous and non-ferrous metals.

Complete details on Claymont Head stocks are published and distributed monthly. If you are not now receiving this stock list, and would like to, just notify the CF&I sales office nearest you.

**CF&I-CLAYMONT PRODUCTS:** Carbon Steel Plates • Alloy Steel Plates • CF&I Electro-Clad Nickel Plated Steel Plates • Clay-Loy High Strength Low Alloy Steel Plates • Flanged and Dished Heads • Pressed Steel Shapes • Manhole Fittings, Covers and Saddles • Fabricated Steel Plate Products • Large Diameter API Pipe

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7085-A

**BULK HANDLING PROBLEMS SOLVED:**

the **EFFICIENCY** of "automation" **+** the **FLEXIBILITY** of unit containers **=**

# TOTE SYSTEM



Compare Tote—a complete, mechanical, automatic bulk handling system based on metal containers plus filling and discharging equipment—with a "push-button" fixed storage bin system. You'll find that Tote offers the advantages you want:

- Compact storage
- Surge capacity between processing and packaging operations
- Accurate and automatic weighing and blending

The labor cost of operating a Tote System is no greater, while the *installation cost of a Tote System is much less.*

IN ADDITION, Tote System retains the flexibility of unit containers:

- *Flexibility in Transportation:* Tote Bins can be shipped by rail or truck, or they can be retained in the plant and filled from bulk hopper cars or trucks.
- *Flexibility in Plant Layout and Procedures:* Tote System can be adapted easily to future requirements. Plant layouts can be changed simply by re-locating discharge stations. Operations can be expanded merely by procuring additional Bins. And the Bins can be used interchangeably for different products.

See Tote at Exposition of Chemical Industries, Coliseum, New York City, Nov. 30-Dec. 4. Booths 858-60.

*Why not let our engineers survey your plant at no obligation? Meanwhile, write for new catalog containing complete details.*

## TOTE SYSTEM, INC.

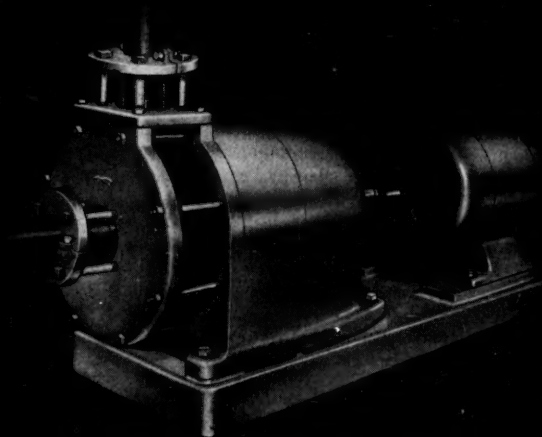
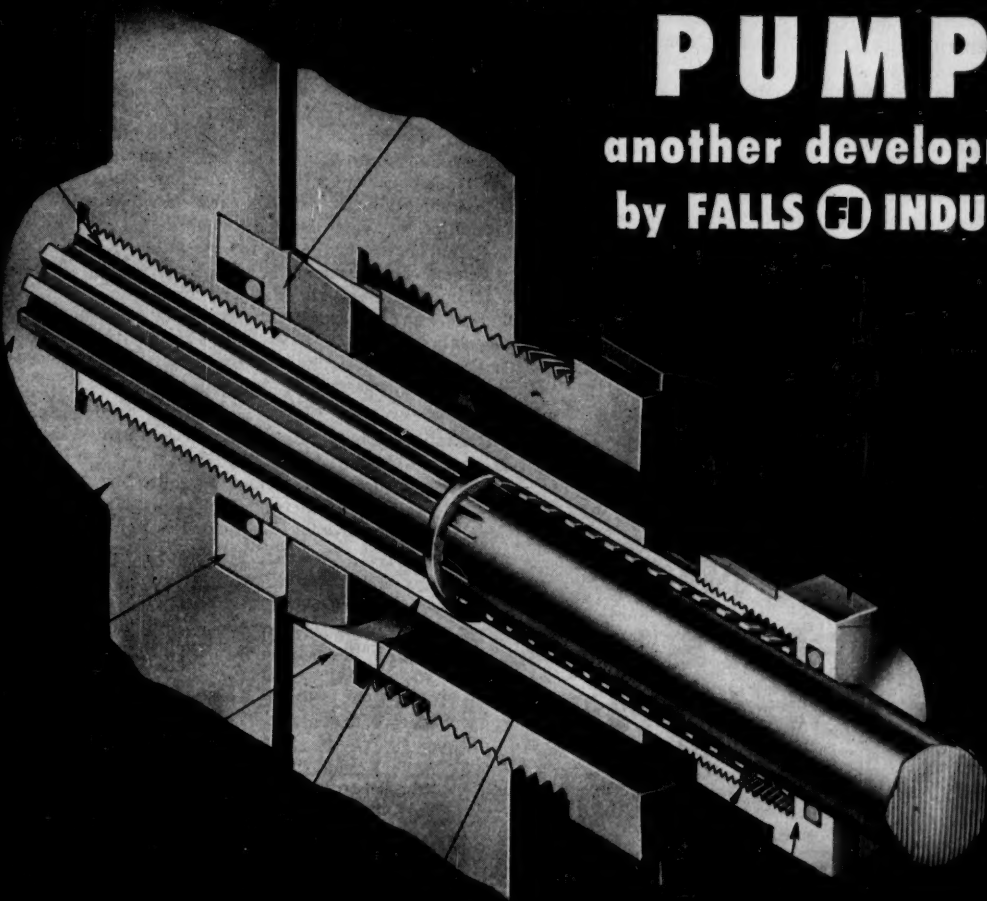
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*... the almost perfect*

# CHEMICAL PUMP

another development  
by FALLS  INDUSTRIES



Impervite pumps are single stage centrifugals, available in 6 standard models from 25 to 300 gpm at 20 to 100 foot heads. Corrosives come into contact only with Impervite impervious graphite, which is unaffected by all corrosives except a few highly oxidizing agents, is immune to thermal shock, and non-contaminating. Bulletin available on request.

SEE OUR CATALOG IN C.E.C.

The secret is in the seal... a self-cooling, self-lubricating carbon-to-carbon rotary seal capable of withstanding temperatures in the 500°F. range. This seal requires no special lubrication, or externally located cooling apparatus which might be contaminated by product leakage. Seal is virtually leak-proof when kept in normal adjustment, and is not attacked by most corrosives.

One user says, "Pump operating continuously for 6 months on 75°C. chlorinated organic acid. Best service ever; no maintenance yet." Another states, "During 3 months, total labor and maintenance has been \$23.00 for 14 Impervite pumps handling hot mixtures of phenol, chlorobenzene, benzene and hot muriatic."

... and Impervite pumps are surprisingly low in cost.

**FALLS  INDUSTRIES, INC.**

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Bristol Dynamaster® Electronic Instruments have proved themselves in thousands of installations. They fully meet today's most exacting standards of accuracy and dependability. They measure almost any variable that can be translated into an electrical quantity (d-c current, d-c voltage, resistance or capacitance). Just a few are: temperature, pH, speed, voltage, smoke density and strain.

Here are some outstanding features that make them ideal for industrial plants, pilot plants, and for research, test, and laboratory use:

1. **Continuous standardization**—eliminates standardizing mechanism and dry cell—no interruption to control. But retains precision standard cell for highest accuracy and stability.
2. **Simple design**—few moving parts.
3. **Easy to use and service**—little or no maintenance required.
4. **Rugged construction**—unaffected by vibration.

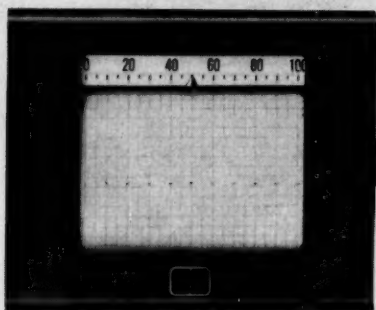
*look to Bristol for  
the complete line of*  
**ELECTRONIC**

**MODELS FOR EVERY PURPOSE.** Dynamaster Instruments are now available as:

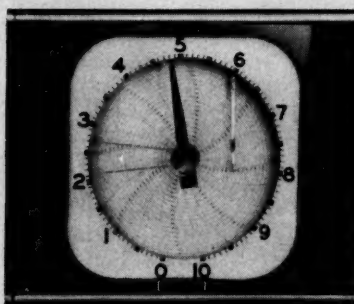
- A. Single-pen, two-pen, and multiple-record (up to 24 points) strip-chart instruments.
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- D. X-Y recorders.
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- I. Pneumatic controllers in both strip- and round-chart models—all types of control action and time-program control.
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- L. Telemetering transmitters.
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- O. Relay-rack mounting models—most models available in case that fits standard 19" relay-rack without modification to instrument or rack, without panel-cutting or masking.

Bristol Dynamaster Potentiometer and Bridge Instruments can be equipped with analog-to-digital encoders of various types for digital readout and computer use. For complete details, write for Bulletins P1245A, P1270, P1271, P1242, and P1282. The Bristol Company, 109 Bristol Road, Waterbury 20, Conn. © T. M. Reg. U.S. Pat. Off.

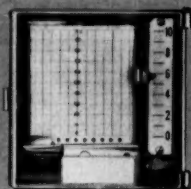
## POTENTIOMETER and BRIDGE INSTRUMENTS



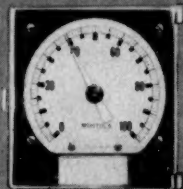
Dynamaster® Electronic Potentiometer or Bridge—records on 11-inch, 120-foot-long strip chart.



Dynamaster® Electronic Potentiometer or Bridge—records on 12-inch round chart, indicates on extra-large scale.



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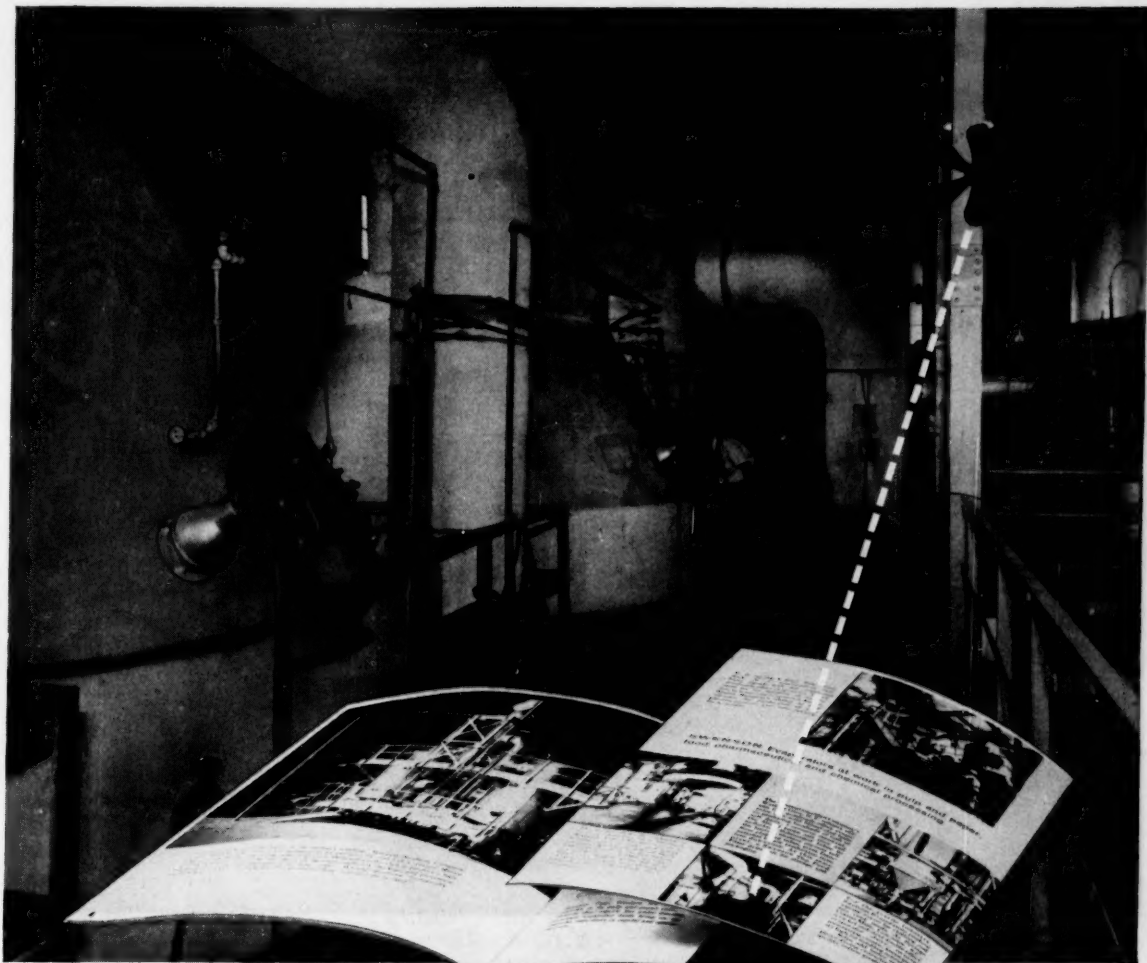


INDICATOR

Plug-in Miniature Electronic Dynamaster Potentiometer and Bridge Instruments—Only 5" x 5 1/4" panel dimensions; ideal for graphic panel instrumentation.

**BRISTOL**  
TRAIL-BLAZERS IN  
PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING  
AND TELEMETERING INSTRUMENTS



\* **A PROCESSING PROFILE**

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Quality conscious, this leading salt manufacturer also keeps a sharp eye on production costs. Keyed to fit both demands, their Swenson Quadruple-Effect Evaporator is producing hundreds of tons of salt daily. Specifically designed for this application and utilizing proper materials of construction, this evaporator provides longer production runs, less downtime!

What Whiting's Swenson Evaporator Division did for this manufacturer can be done for you. Send for "Processing Profiles," the colorful new booklet of performance reports, showing evaporators, crystallizers, filters, pulp washers and spray dryers *on the job* ... helping up-to-date processors do more, faster and better. *Swenson Evaporator Company, 15620 Lathrop Ave., Harvey, Ill.*

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# SWENSON



WHITING—MANUFACTURERS OF CRANES; TRAMBEAM HANDLING SYSTEMS; TRACKMOBILES; FOUNDRY AND RAILROAD EQUIPMENT.

CHEMICAL ENGINEERING—September 7, 1959



## flexibility in a cone...

Stokes Conical Rotating Vacuum Dryers offer unparalleled operational and application flexibility. Proved "in service" design of Stokes vacuum dryers meets requirements of a wide range of products. There is no guesswork in calculating the vaporizing capacity you need or the production rate for a given material. Stokes Dryers are engineered and manufactured specifically for vacuum service... and Stokes has been active in the field of vacuum applications for over 40 years.

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- **self-wiping vacuum tight valve**, worm-gear actuated, for easy and rapid discharge
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- **maximum dust protection**, filter capped to inlet, minimizes need for external collector
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- **double walled construction**—ideal for steam or hot water heating

Stokes vast experience in vacuum drying techniques can be put to work for you. Why not write or call Stokes for details... today.

*Processing Equipment Division*  
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# STOKES



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are available in **6** forms:

**TABLETED • EXTRUDED • GRANULAR  
SPHERES • FLAKES • POWDERS**

We'll assist you in developing the best and most economical catalyst for your needs. Our more than 20 years catalyst experience and acres of production and research facilities are ready to work for you. Harshaw produces carloads of catalysts every week — this capacity guarantees prompt shipment of your catalyst order.

**PREFORMED CATALYSTS**  
to fit special process requirements

Hydroforming • Cyclization • Oxidation • Dehydrogenation  
Dehydration • Desulphurization • Alkylation • Hydrogenation,  
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**CATALYTIC CHEMICALS SUPPLIED BY HARSHAW**

Aluminum Nitrate	Metallic Soaps (Cobalt, Manganese)	
Manganese Nitrate Solution	Cobalt Nitrate	Copper Nitrate
Nickel Carbonate	Nickel Formate	Nickel Nitrate
Nickel Sulfate	Sodium Methoxide	Zinc Nitrate

Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

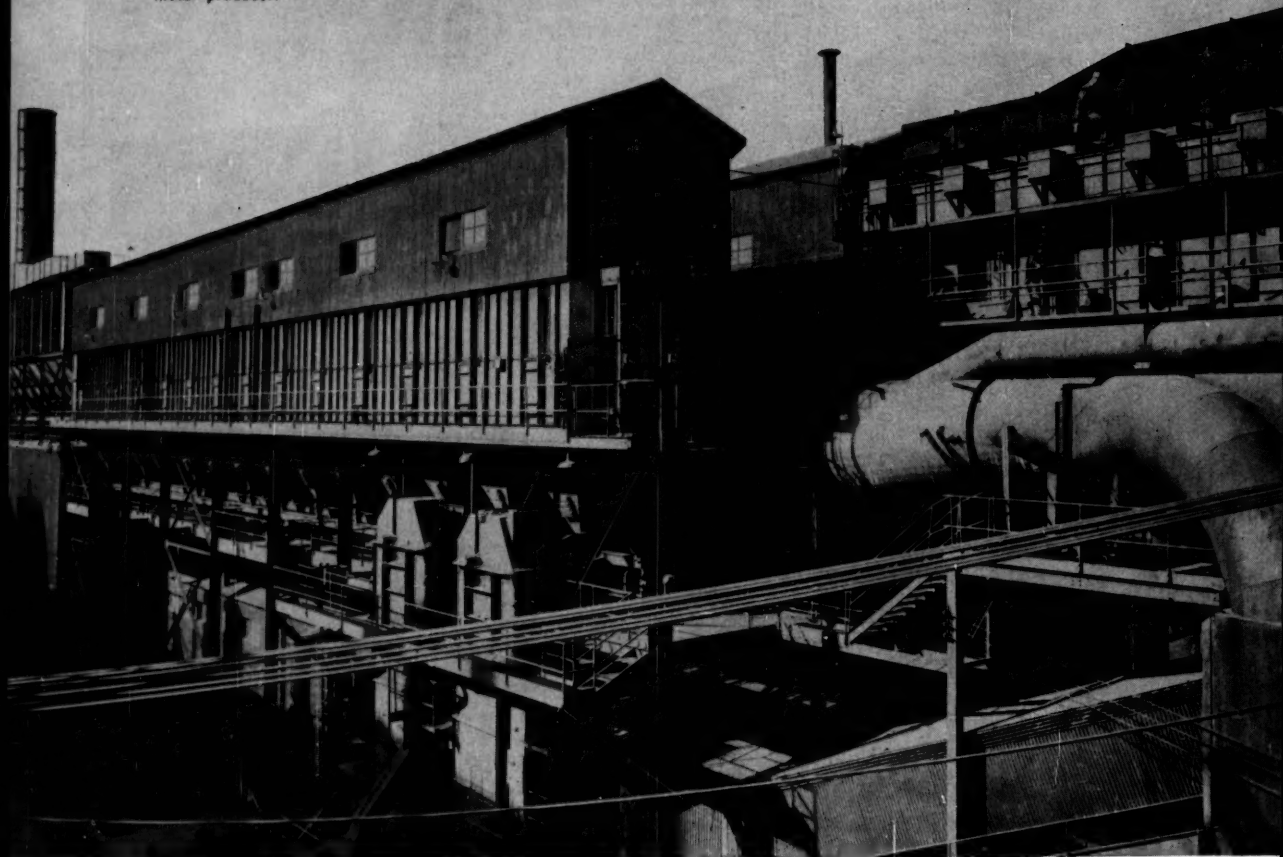


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\$3,000,000 annual recovery of metal-laden dust enables user of this gigantic Dracco System to reap multiple returns on investment. 500,000 cfm-capacity system handles about 50,000 tons of the material per year, serves all process needs at non-ferrous metal producer.



# big payoff, quick payout....

## with *Dracco Dust Control Equipment*

Big installations.

Big benefits.

These are results of Dracco Dust Control Engineering. Over 40 years experience in the industry assures soundly engineered systems, solidly built to last. Some of the world's largest installations,

such as the one shown here, are being made by Dracco.

But even if your plant is small, you can profit from Dracco Dust Control. You can eliminate raw material waste, cut plant clean-up costs, reduce wear on machinery, liquidate health hazards and halt air pollution with a system en-

gineered to fit your needs. These benefits can pay for equipment and installation costs many times over, regardless of system size.

Why not put your dust problem in Dracco's capable hands? Chances are we've solved many problems just like yours.

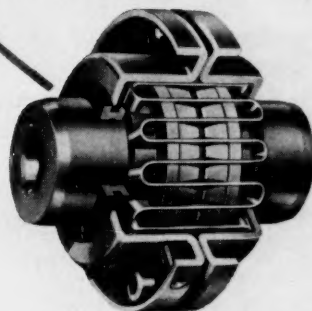
**DRACCO** DIVISION OF  
FULLER CO.  
4040 East 116th Street • Cleveland 5, Ohio

**DRACCO** *airstream conveyors*  
dust control equipment

(Pronounced Dray-co)



Photo shows portable pump unit connected to internal combustion engine by a Type F FALK Steelflex Coupling



**Basic Type F  
FALK STEELFLEX COUPLING  
fills the needs of 90%  
of industrial applications**

This cutaway view shows the exclusive Steelflex design which provides torsional resilience with the strength of steel. This torsional resilience spreads peak or shock loads over a relatively long increment of time, thus greatly reducing stresses in connected machinery.

The versatile Type F Steelflex can be used horizontally or vertically, without modification or special parts. It is ideally suited to 9 out of 10 applications. For unusual applications involving overload conditions, extended shafts, brakes, etc., standard designs of dual-purpose Steelflex couplings are available.

For most applications, you can give your machines the extra protection afforded by FALK Steelflex Couplings at no extra cost!

## How FALK Couplings give your connected machinery Double Protection

**FIRST:** They protect against shaft misalignment. Some degree of shaft misalignment is unavoidable—and unless protective compensation is provided, additional loads are developed on shafts, bearings and other revolving elements. The result is excessive wear-and-tear—and often actual breakage....FALK Steelflex Couplings compensate for either angular or parallel misalignment—or for the more serious condition involving both! The exclusive Steelflex gridmember which joins the two hubs is not fastened to either hub; thus, either hub can shift in any direction without imposing a load on the other hub.

Yet, important as protection against shaft misalignment is to you, it is only one function of the truly flexible FALK Steelflex Coupling.

**SECOND:** They protect against torque fluctuations which create excess wear on connected machines and frequently induce destructive shaft misalignment. The exclusive FALK Steelflex grid-groove design cushions shock loads, dampens vibration, reduces impact loads as much as 30 per cent. You get this extra margin of protection that can mean the difference between operating and breakdown! You save on maintenance costs. And—you prolong the service life of your machines!...For complete information, ask your FALK Representative or Authorized Distributor. Or—write direct for Bulletin 4100.

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Manufacturers of Quality Gear Drives and Flexible Shaft Couplings

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...a good name in industry



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Listed by Underwriters' Laboratories as rain-tight and suitable for use in hazardous atmospheres: Class I, Groups C and D; Class II, Groups E, F and G. Electrical rating: 20 amps, 125, 250 or 460 vac; 1 hp, 115 vac; 2 hp, 230 vac.



## **Here's the switch for your toughest exposed locations**

Big, ruggedly built, armored against the effects of hot sun, heavy rain, dry blowing dust, or explosive atmosphere, this Series "CX" switch gives precise circuit control for long-life maintenance-free operation.

Seals keep out dirt, dust and moisture. Housings are cast aluminum. Lever arm is adjustable thru 360 degrees and length can be varied from 1 inch to 3½ inches. In the housing are two single-pole double-throw snap-action switching units. One switch is operated by

clockwise rotation of the lever arm—the other switch by counter-clockwise rotation. Operating force—4 lbs. maximum.

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Your nearest MICRO SWITCH branch office will be glad to give you complete information. Look in the Yellow Pages. Send for Data Sheet 156.

**MICRO SWITCH...FREEPORT, ILLINOIS**

A division of Honeywell

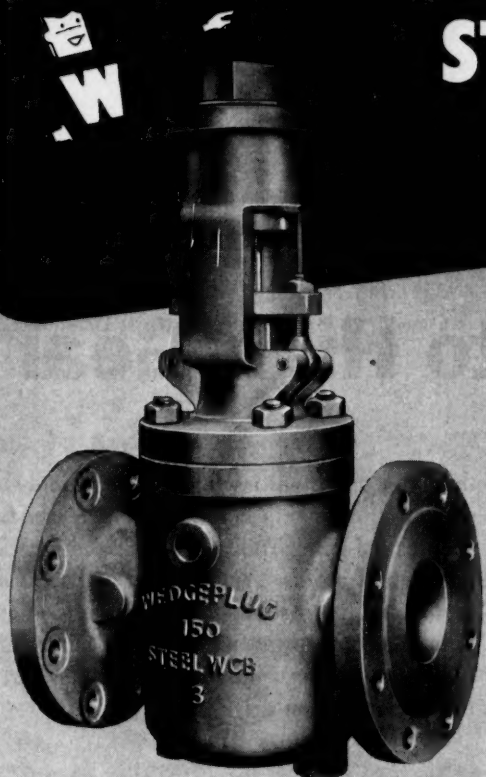
In Canada: Honeywell Controls Limited, Toronto 17, Ontario



# **Honeywell**

**MICRO SWITCH Precision Switches**

# WEDGEPLUG STEAM-JACKETED VALVES



Specify Wedgeplugs and get  
the Best Valve for use on  
lines handling:

**ASPHALT  
TAR • PITCH  
CRUDE  
BOTTOMS  
FATS • SOAP  
RESIN  
SULPHUR**

## ...for handling VISCOUS LIQUIDS

Typical Services Where Steam-Jacketed Wedgeplugs  
Have Outstanding Performance Records

ASPHALT .....	+500° F. — 100 PSI
RESINS .....	+400° F. — 80 PSI
MOLTEN SULPHUR ...	+275° F. — 80 PSI
SOFT PITCH .....	+900° F. — 440 PSI

- **POSITIVE CONTROL** at high temperatures. The Plug lifts, turns and re-seats in one, quick, easy operation. Valve seats are protected; no field adjustment is necessary for varying temperatures.
- **NON-STICKING:** Because of its protected-seat design, the Wedgeplug Valve will not stick when handling viscous products that harden, congeal, or crystalize at ordinary temperatures.
- **NO LUBRICANT USED:** Wedgeplug design eliminates the need for expensive plug-seal lubrication—thus saving maintenance cost.
- **NO CONTAMINATION:** Non-lubricated design eliminates product contamination from grease.
- **CORROSION PROBLEMS:** Steam-Jacketed Wedgeplugs available in Carbon Steel; and, where corrosion problems might be encountered, can be supplied in various Steel Alloys.
- **REMOTE CONTROL:** Wedgeplug Valves can be supplied wrench, handwheel, or gear-operated; or, for remote control through use of electric, hydraulic or air motor.

**WEDGEPLUG VALVE COMPANY**

*Division of*

**STOCKHAM VALVES & FITTINGS**

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**ABSOLUTE SHUT-OFF  
AT HIGH TEMPERATURES**

# Plan '59

## *To modernize now for growth and profits* **Goes Into High Gear**

**In 1959, industry will spend more money than ever before to modernize its plant and equipment. But it is not spending enough to do the job that needs to be done.**

Manufacturing companies\* now plan to spend a total of \$24.5 billion on modernization in the four years 1959-1962. This will be enough to replace roughly 70% of the obsolete facilities that were on hand at the beginning of 1959. But it will still leave us far short of our goal. It would take several years, at a higher rate of investment than is now planned, to wipe out obsolescence and give the U. S. a truly modern industrial plant.

These facts stand out from the 12th annual Survey of Business' Plans for New Plants and Equipment just completed by the McGraw-Hill Department of Economics. This new survey shows that industry has made a remarkable start on the modernization job that a previous editorial in this series described as "the most expensive task to be performed in America in this new year of 1959." The full cost of modernization has been found by the McGraw-Hill Department of Economics to be \$33.3 billion for manufacturing, and \$95 billion for all business.

For the past several months, McGraw-Hill publications have been devoting special attention to new developments in plant and equipment

that offer opportunities for modernization. Our special effort to help industry in this regard has been called "Plan '59": to modernize *now* for growth and profits. This editorial will summarize the progress made so far with "Plan '59" and point out some of the areas where business and public policies can do still more to accelerate the modernization drive.

### **A Good Start**

**Business investment in new plant and equipment has picked up sharply since the low point of the 1958 recession. Plans for 1959 now show a 7% increase over 1958 for total capital investment. And the increase in expenditures for modernization is much sharper.** Moreover, companies already have substantial plans for the years after 1959. New orders for industrial machinery, which are a good index of modernization plans, also are running well ahead of last year.

For the four-year period 1959-1962, manufacturing companies expect, on the average, to devote 65% of their plant and equipment outlays to modernization. This is the highest proportion reported in a McGraw-Hill survey since 1950. In dollar terms, manufacturing companies plan to spend \$24.5 billion on modernization during the next four years.

This is an impressive figure, but it does not look so large when compared with the total need

\*Excluding petroleum refining, which is reported as part of the oil industry in the data discussed in this editorial.

for modernization in manufacturing industries. As noted above, a previous McGraw-Hill study (conducted in August 1958) found that it would cost almost \$35 billion to replace all the facilities that manufacturing companies then considered obsolete. Thus, present plans for modernization are enough to wipe out only 70% of the backlog of obsolete facilities by 1962—and this makes no allowance for the additional facilities that will be made obsolete by new machines and new processes introduced during the next four years. When these new developments are considered, present plans for spending may represent only half the job that will actually need to be done.

### How To Accelerate

What can be done to accelerate the drive to modernize our industrial plant and equipment? Two of the greatest aids would be:

**(1) Improve present provisions under the tax law for depreciation, to help industry retain more of the money it needs to carry out this massive job of modernization;**

**(2) Contain inflation, to preserve the purchasing power of the money industry sets aside to replace obsolete facilities.**

At first glance, the supply of funds from depreciation allowances appears to be more than adequate. For manufacturing as a whole, depreciation allowances—the primary source of cash for modernization—will total \$8.3 billion in 1959, compared with present modernization plans of \$6.4 billion. Thus some extra funds will be available to support a further step-up in modernization in 1960.

Unfortunately, however, these depreciation funds are not evenly distributed from industry to industry, or from company to company. For example, in several of the metalworking industries, the prospective flow of cash from depreciation during the next four years is much less adequate than for manufacturing as a whole. These are industries with relatively large modernization backlogs, and they also are industries made up mostly of small or medium-size companies that have difficulty tapping the public money market.

As a result of these industry and company differences, there are many individual cases where shortages of funds limit the amounts of modernization now planned. In the McGraw-Hill survey, nearly half of all companies participating said that they would spend more on new plants and equipment if the depreciation allowances permitted by the tax law were increased substantially over the next few years. Most of these were relatively small companies. Their answers suggest that revision of the tax rules on depreciation should receive the most careful consideration as a spur to faster modernization.

The problem is complicated also by the threat of further increases in the national price level, which would necessarily include prices of capital goods. If "creeping inflation" resumes its march during the next four years, depreciation allowances based on present costs will be much less adequate for future needs. This points up the importance of national economic policies to maintain price stability. Unless this can be maintained, industry's dollars will not go far enough to do the modernization job that is needed.

### Plan '59 Carries On

Industry's drive to modernize is now well underway. It can make a key contribution to our national strength and prosperity in 1959 and the years ahead. But the biggest part of this job is before us. It is up to the policy makers—in both business and government—to see that the job is done.

*This message was prepared by the McGraw-Hill Department of Economics as part of our company-wide effort to report on opportunities for modernization in industry. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or part of the text.*

*Donald C. McGraw*  
PRESIDENT

McGraw-Hill Publishing Company, Inc.



# FLUID PROCESSING

RODNEY HUNT MACHINE CO., Process Equipment Division, 31 VALE STREET, ORANGE, MASS.

## RODNEY HUNT TURBA-FILM PROCESSORS SOLVE COMPLEX PROBLEMS IN MANY APPLICATIONS

Manufacturers of chemicals, foods, pharmaceuticals and many other products have found in the Rodney Hunt mechanically aided thin-film processors a simplified solution to complex problems in concentration, deaeration, distillation, evaporation, homogenization and other processes. In one pass—continuously and rapidly—the Turba-Film Processor provides heat and mass transfer for processing liquids and slurries. Since product quality can be checked continuously and controlled instantly, production errors and costly re-runs of reject material are eliminated.

### HOW THE TURBA-FILM PROCESSOR WORKS

The feed stream enters the TURBA-FILM PROCESSOR at the top of the thermal section shown in Fig. A. The high speed rotor blades force all of the feed against the inner shell surface by centrifugal force and simultaneously form descending fillets of liquid product on the leading edge of each rotor blade as illustrated in Fig. B. The fillets rotate with the blade movement, imparting compressive and rotational forces against the film of liquid at the heat transfer surface of the inner shell, forcing the film to combine with the fillets. The product material at the shell wall normally possesses a boundary-layer flow distribution but the design of the rotor blades makes the "effective" thickness of this product film considerably less than the clearance between the rotor blades and the shell wall. The fluid which would normally reside at the shell surface thus descends as a component of the fillets, traveling through the entire thermal section in a very short and precisely controlled period of time... frequently as little as a few seconds.

Where an application involves vapor-liquid equilibrium such as occurs in mass transfer operations of concentration, dehydration, deodorization, evaporation, heterogeneous reaction, absorption, stripping or distillation, a highly active interface is established at the surface of the fillets where the liquid and vapor phases are in contact. This dynamic activity greatly implements the transfer of material from one phase to the other. The vapor or gas passes upward in counterflow through the thermal section to the separator from which entrained material may be refluxed or recycled to the thermal section with maximum utilization of heat and mass transfer potentials.

### TURBA-FILM PROCESSORS OFFER THESE COST-CUTTING ADVANTAGES

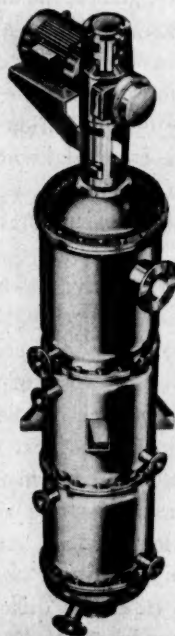
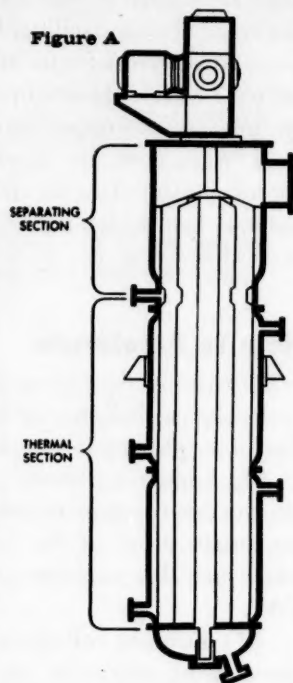
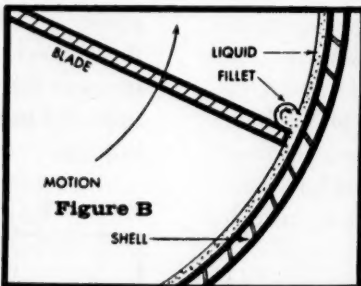
**Simplified installation...** compact design, readily accessible piping connections, and the new support brackets combine to make installation quick, easy and economical.

**Less floor space...** because of high capacity, continuous operation and low process hold-up, less floor space is required than with conventional equipment.

**Quality control...** since relatively small amounts of product are in process at any given moment, the condition of the product can be checked continuously and controlled instantly.

**Minimized cleaning...** Turba-Film units can operate for long periods of time without cleaning because formation of boundary layers, crusts, crystals and other deposits on heat-transfer surfaces is almost completely eliminated.

**Flexibility of use...** Low process hold-up permits quick and easy changeover from one product to another to provide for extremely broad flexibility of use.



### FILL IN COUPON FOR MORE INFORMATION ABOUT RODNEY HUNT PROCESSING EQUIPMENT

Please send me the bulletins checked.

- ☐ THE TURBA-FILM PROCESSOR
- ☐ THE VACU-FILM PROCESSOR
- ☐ THE LABORATORY VACU-FILM PROCESSOR

Name.....

Title.....

Company.....

Address.....



Mail to: Rodney Hunt Machine Co., Process Equipment Division, 31 Vale Street, Orange, Mass.

DEVELOPMENTS ...

SEPTEMBER 7, 1959

# Chementator

C. H. CHILTON

**Air Products has an Air Force contract to supply 7,500 lb. of nitrogen trifluoride. AF's use of  $\text{NF}_3$  hasn't been revealed.**

**California Chemical will be first Western producer of maleic anhydride. Plant at Richmond, Calif., will have capacity of 20 million lb./yr. Output will be marketed by Oronite.**

**First commercial production of foamed aluminum begins this fall. Dynamic Metals Corp., Houston, will make 6 million lb./yr. via Bjorksten process, in which zirconium hydride is mixed with molten aluminum. Product will go into roofing and building panels.**

## **New unit skims off fast reactions**

A new reactor design that maximizes yield of iso-octane is heart of a 6,600-bbl./day HF alkylation unit now under construction at Phillips Petroleum's Kansas City refinery.

Phillips engineers term the new design "an important breakthrough in alkylation technology." It came about as result of fundamental studies of chemical mechanisms and reaction kinetics in a special pilot plant at Bartlesville, Okla.

In exploring the kinetics of competing reactions, Phillips researchers focused on such desirable reactions as (a) formation of butyl fluoride from butylene and HF and (b) formation of iso-octane by reaction of butyl fluoride and isobutane. These reactions were found to be much faster than formerly thought, requiring only a few seconds instead of several minutes. On the other hand, such undesirable reactions as skeletal rearrangement of alkyl groups, disproportionation and addition reactions are relatively slow.

Another discovery was that proper control of conditions for mass transfer would promote the desirable reactions at the expense of the undesirable ones.

Product of the new reactor has a higher proportion of high-octane alkylate than that from conventional units. Boiling range of alkylate is lower than normal; heavy, low-octane components are virtually eliminated.

The new reactor design promises lower investment per barrel of product. In addition, Phillips expects to need much less cooling water (on the reactor itself) and steam (for downstream fractionation).

Further studies of various fractionation schemes, made with the aid of a high-speed digital computer, have convinced Phillips engineers that for alkylation plants under 6,000 bbl./day a single, multipurpose tower is the optimum. However, this advantage has to be foregone on the slightly larger Kansas

**CROUSE/HINDS**

# Condulet®

**electrical equipment**

**the one complete line  
for corrosive locations**

**RESISTS** chemical and  
galvanic corrosion

**RESISTS** acids, alkalis, salts

**RESISTS** varying concentrations  
and temperatures of corrosive  
liquids, vapors, gases, dusts

Corrosion problems would be simple if there were a single material which would resist all corrosive substances.

Since there is not, Crouse-Hinds provides electrical equipment in four materials which offer a selection to meet virtually every known corrosion problem . . .

Photo shows Feraloy Condulet conduit fitting after several years exposure to hydrochloric acid. Note extreme deterioration of conduit.

**FERALOY®** features the desirable characteristics of cast iron: strength, corrosion resistance, versatility, adaptability, economy. Plated with zinc and cadmium, Feraloy Condulets will combat most corrosive elements.

**ALUMINUM ALLOY** develops its own self-repairing oxide film which resists a number of corrosive conditions. Copper-free Aluminum Alloy Condulets effectively resist galvanic corrosion.

**PLAST-A-COAT**, a polyvinyl chloride, is a resilient coating which withstands abrasion and repels corrosion from caustics, alkalis and heavy mineral acids. Tough, non-peeling, it also acts as an insulator.

**SILICON BRONZE**, when all other materials fail, can be furnished for the most extreme corrosion problems. Counteracts virtually all alkalis as well as salt water, sulfur gases, etc.

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information on  
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Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.  
Crouse-Hinds Instrument Company, Inc., Silver Spring, Md.

City job because a single tower would have to be greater than 13 ft. dia., the limit for rail transportation.

Phillips is making its newly won know-how available through suitable licensing arrangements.

### Acrylics reinforce other plastics

Some heretofore obscure acrylic monomers are now coming into their own with the growing importance of cross-linked coatings and resins.

This group of chemicals includes allyl methacrylate and a series of glycol esters—ethylene glycol dimethacrylate, triethylene glycol and tetraethylene glycol dimethacrylates. Added in small amounts to work-horse resins, they greatly improve solvent and heat resistance of the finished products. Outstanding example is their beneficial effect on acrylic coatings for automobiles and appliances.

Three-year-old Sartomer Resins Inc. makes this line of products at Essington, Pa. Borden has one such commercial product, called MPL, and Rohm & Haas has an experimental monomer called X-970. Borden describes MPL as capable of vinyl-type addition, extremely reactive in copolymerization, usable with a wide variety of monomer systems.

The acrylic additives are also suggested for use with vinyl plastisols to improve tensile strength, solvent and abrasion resistance. In plastisols they probably form some sort of mechanical structure for vinyl chloride chains, rather than interact chemically. Replacing all or part of the plasticizer, they also make plastisols more workable by decreasing viscosity.

Sartomer says its products are now being used to impart improved properties to acrylic buttons, watch crystals and false teeth. Enticing the company is a potential market for cross-linking agents in the manufacture of ion exchange resins. Here the acrylic monomers would have to compete with divinyl benzene, already well established for this use.

### Spray dryer turns out polyphosphates

A short cut in the manufacture of detergent phosphates, first developed in Germany, now has a solid position in the U.S.

The new technique uses a one-stage spray dryer-calciner for converting disodium phos-

phate solution into polyphosphate powder. Two steps are used in the conventional process. The first makes orthophosphate in a spray (or drum) dryer; this material is then converted to polyphosphate in a rotary kiln (*Chem. Eng.*, Apr. 1957, pp. 162-164).

Developer of the new process is Knapsack-Griesheim AG., a subsidiary of Farbwerke Hoechst. Knapsack's production unit has a capacity of 120 tons/day. Food Machinery's Westvaco division put in a German-built unit of similar design (capacity not disclosed) at its Newark, Calif., plant last year. By this spring, bugs had been worked out and unit was working "beautifully."

In the conventional phosphate spray dryer, heat is supplied by hot gases from a separate combustion chamber. In the Knapsack design, a ring-type burner is mounted directly on the dryer so that its flame actually is inside the dryer shell. The phosphate solution is sprayed through the hot flame, which quickly dehydrates it and converts it to the desired product form.

By slight alterations in operating conditions, the spray dryer can produce either tetrasodium pyrophosphate or sodium tripolyphosphate, or a mixture of the two in any desired ratio.

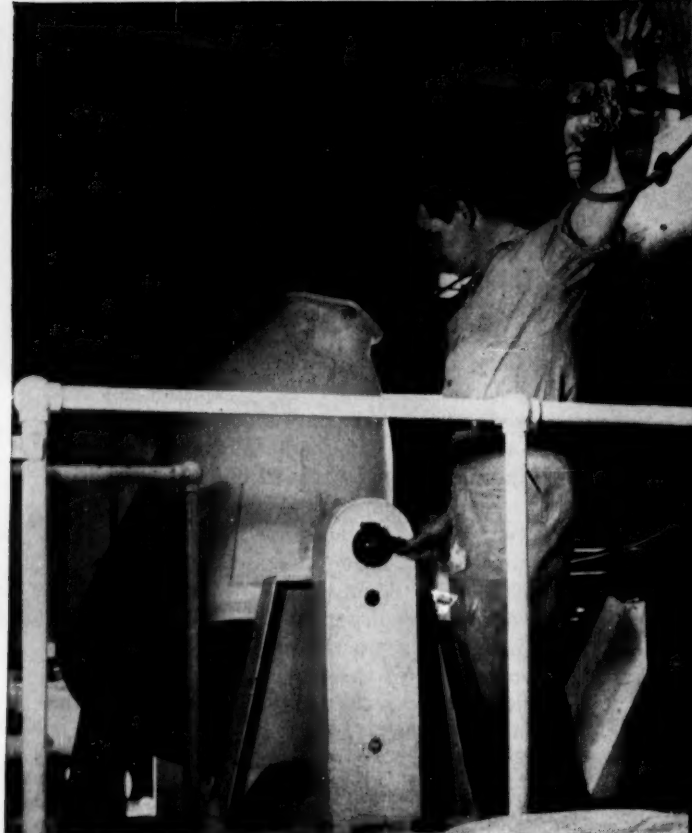
Another one-stage process has been used several years by Virginia-Carolina Chemical at Fernald, Ohio (*Chem. Eng.*, Dec. 1954, pp. 320-323). V-C uses the opposite approach, eliminating the orthophosphate dryer and doing the entire job in the rotary kiln. Product from the kiln is ground in a hammer mill, whereas the Knapsack spray-dried product needs no crushing.

### New cellulosic fiber hits the market

Add the name Zantrel to your roster of man-made fibers vying for the confused consumer's apparel dollars. And if you've reached the point where you can't tell the fibers without a scorecard, here are Zantrel's vital statistics:

It's a cellulosic fiber whose molecules are twice as long as rayon's (500 anhydroglucose units vs. 250); intramolecular arrangement is said to be more compact and orderly. Its prospective U.S. manufacturer, Hartford Fibres Co. (a division of Bigelow-Sanford Carpet Co.) has asked Federal Trade Commission

(Continued on page 68)



## P-K LIQUID-SOLIDS® BLENDER AT UNIVERSAL CLAY PRODUCTS CO.

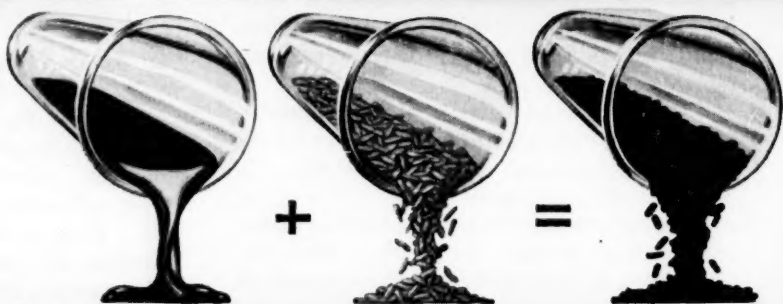
Clay body mixing is faster and simpler with a 20 cu. ft. P-K Liquid-Solids Blender at Universal Clay Products Co., Sandusky, Ohio. The unit pre-blends, adds water, post-blends and discharges 900 pounds of spherically granulated body clay for electrical porcelain. Time is only 12 minutes. Previously this operation required a pulverizer and three-belt conveyor system built around conventional miller-type mixing equipment. Mixing time reduction: 20%. Equipment and installation savings: 50-55%.

The controlled spherical granulations produced by the Liquid-Solids Blender give still further advantages. They fire into a stronger porcelain. And they give easier release on some dies. This speeds production in piece-work operations.

As shown at far right, clean-up requires only hosing down with water. All blender surfaces are freely accessible. Complete discharging of batch is accomplished in minutes.

Before installation, Universal Clay pre-tested formulations at the P-K pre-test laboratory in East Stroudsburg, Pa. Moisture content and control were worked out. Blending procedures were established. All of which minimized scale up and procedural adjustments.

Universal Clay makes electrical pole-line and switch-line porcelains and foundry and custom-tailored ceramics. A broader application of P-K Liquid-Solids Blending is planned in the future.



## BLENDS ANY LIQUID

A new centrifugal Liquid-Solids blender has evolved from P-K's patented "Twin-Shell" design. It blends never-before-practical combinations of liquids and solids! It reduces conventional blending operations to a single step!

For new combinations of liquids and solids, this amazing blender offers untold advantages. Applications are limited only by imagination. They range from chemical reactions to coating very light solids such as cork, to producing all types of controlled granulations from fine to coarse.

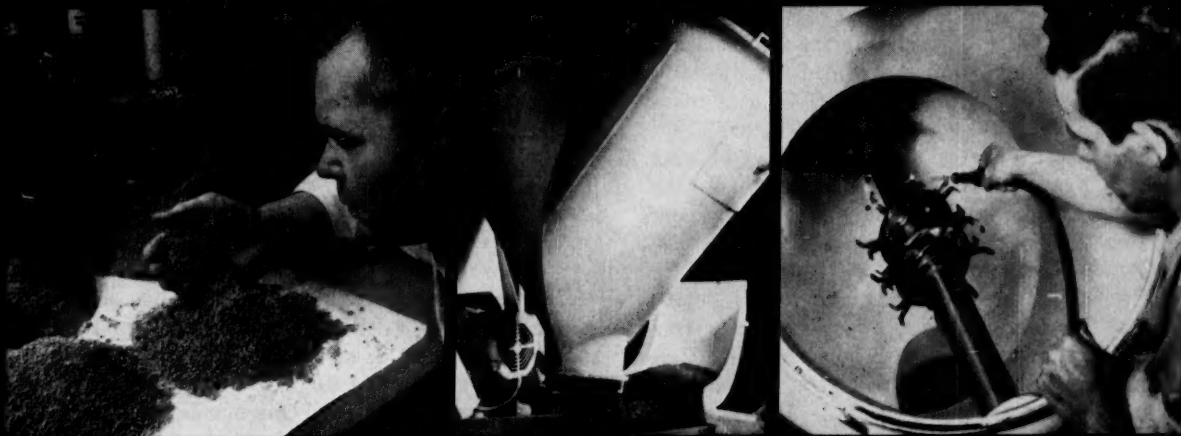
In conventional applications, the one-step P-K Liquid-Solids blender often eliminates two and three separate stages of blending, pulverizing and screening. It replaces a multiplicity of equipment. It reduces equipment invest-

ment and materials handling costs.

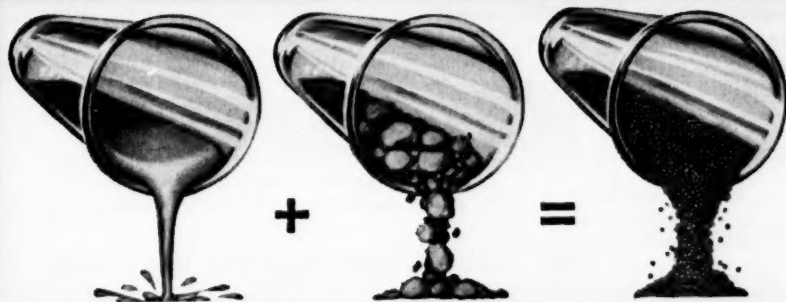
P-K Liquid-Solids units blend from ½% liquids by weight to whatever percentage solids can absorb and still remain a solid. Blending requires minutes, not hours. It involves four simple actions: 1) Dry Solids are charged to about 65% of shell volume. 2) Solids are tumbled and aerated to break up agglomerates. 3) Atomized liquid is dispersed through patented centrifugal spray discs. 4) Product is discharged from the bottom of the blender.

All surfaces of the blender are freely accessible. The Liquid-Feed bar is easily removed. These features speed cleaning and safeguard against contamination. Sizes range from laboratory models to 50 cu. ft. capacity.

# CUTS MIXING TIME 20% REDUCES INVESTMENT 50%



CONTROLS GRANULATION • COMBINES OPERATIONS • SIMPLIFIES CLEAN UP



## WITH ANY SOLID

**FREE PRE-TEST OFFER.** You can preview blending economies at our Laboratory. Pre-testing predicts savings in processing and handling and realistically demonstrates the unique performance of the P-K Twin-Shell blender.

Our pre-test facilities for blenders—and also for P-K

Vacuum Tumble Dryers—are at your disposal. Send or bring your test materials. For complete information call (Stroudsburg-Hamilton 1-7500) or write George Sweitzer at our East Stroudsburg Headquarters, 1509-15 Hanson St.

\* Patented

**Patterson  Kelley**

Chemical and Process Equipment Division, East Stroudsburg, Pa.

approval to identify the fiber as a "polynosic" (many fibrilles) rather than a rayon.

The new fiber has been produced in France since May by Compagnie Industrielle de Textiles Artificiels et Synthétique at a rate of several million lb./yr. Hartford plans to begin commercial production next summer at Rock Hill, Conn. Until then Hartford will sell French-made fiber.

Zantrel's initial shrinkage is claimed to be negligible, progressive shrinkage is nil and it can be Sanforized. It is dimensionally stable and does not swell when wet. Fabrics made from Zantrel resemble luxury cottons.

Three other cellulose, introduced earlier this year (*Chementator*, Mar. 9, p. 69) by American Viscose, American Enka and Courtaulds, claim similar advantages. But none of them, says Hartford, has the "friendly" hand of Zantrel.

Aiming initially at apparel markets, Burlington Industries will produce finished Zantrel fabrics, alone and in blends with natural and other synthetic fibers. At 47-50¢/lb., Zantrel is priced above rayon but well below polyester and acrylic fibers.

Original concept of how to make the new fiber came from Tachakawa Research Laboratories in Japan. Process development work has been under way in France since the early '50s, and Societe Chimiotex of Switzerland now has licensing rights. Plants are being built by Fabelta in Belgium and Societe de Viscose in Switzerland.

### Government axes boron fuels program

In a move which comes as no great surprise to *Chementator* readers (July 27, p. 60), the government last month canceled its huge, costly boron fuels production program, even as its two major plants approached full-scale operations.

Still reeling from this blow are Olin Mathieson and Callery Chemical. OM was readying the Air Force's \$45-million plant at Model City, N. Y. Callery had the Navy's \$38-million plant at Muskogee, Okla., just about tuned up.

Only unexpected twist was that the Air Force made the first move, one day ahead of the Navy. Navy's waning interest in boron fuels was evident in June, when it canceled its contract with Metal Hydrides for operation of a \$4.5-million sodium borohydride plant at Danvers, Mass. And the Navy had no pro-

gram under way for engines or aircraft to use boron fuels.

Air Force's program for development of the J-93-5 engine met the same fate as the boron fuels. The J-93-5 was being designed to burn a hydrocarbon in the turbojet portion and to use boranes in the afterburner.

Still uncertain as of mid-August were the Air Force's intentions re the B-70 bomber and F-108 fighter interceptor, which would have used the J-93-5. As an alternative, these planes can use the J-93-3, an engine burning hydrocarbons in both turbojet and afterburner. (The "Dash Three" is unaffected by the recent cancellations.) Look for stepped-up activity in development of improved hydrocarbon jet fuels consisting of saturated cyclics (*Chementator*, Apr. 20, p. 78).

Meanwhile, research will continue in the boron fuels field. Arthur D. Little, Inc., is proceeding with its economic and process comparisons; Aerojet is currently starting up its pilot plant at Sacramento; AFN is continuing its development work; and Olin Mathieson and Callery, both of which own private facilities for making boranes, will go ahead with further work in liquid and solid high-energy fuels.



### Tomorrow's Technology

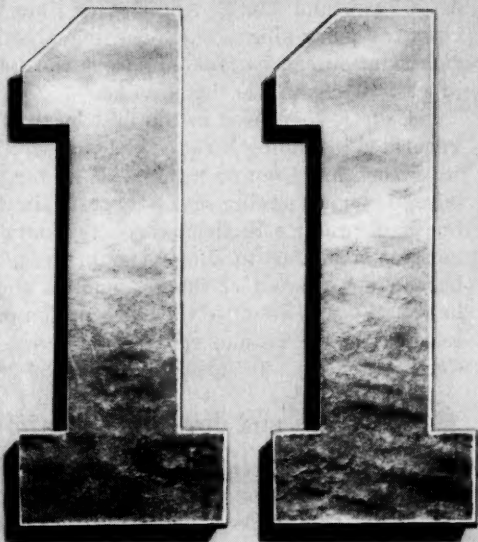
Today's embryonic developments which have special significance for chemical engineers

#### ● Pure SiC seeks electronic jobs

New discoveries in solid-state physics, instead of hastening the demise of the vacuum tube, may actually give it a new lease on life.

Idea is to use a semiconductor crystal as the electron emitter in a vacuum tube in place of the usual hot-wire cathode. The crystal would consume a negligible amount of power and would not require any warmup time.

Although hyperpure silicon and germanium can be used as emitters (as first learned by workers at Bell Telephone Laboratories), present attention is focused on silicon carbide. Westinghouse researchers recently found that density of electron flow from SiC crystals is comparable to that from the usual vacuum tube cathode. This leads to speculation that the electronic tube of the future may be "transistorized."



**B & A<sup>®</sup>**

## **METALLIC NITRATES**

**Aluminum**

**Barium**

**Cadmium**

**Chromium**

**Cupric**

**Ferric**

**Lead**

**Magnesium**

**Manganous**

**Mercuric**

**Nickelous**

### **Which ones can serve your needs best?**

If you use metallic nitrates, chances are one or more of those listed here will meet your needs. And, if that's the case, you'll find Baker & Adamson<sup>®</sup> is your *best* source of supply. Here's why:

#### **Highest Purity!**

B&A Metallic Nitrates have long set industry standards for highest purity and quality. They are available in purified or technical grades for general manufacturing use . . . in reagent grade for more exacting requirements.

#### **Dependable, basic source!**

Baker & Adamson is the *only* producer of metallic nitrates with its own nitric acid production facilities. This is your best assurance of continuous, dependable supply!

#### **Continuous production from 2 plants!**

B&A Metallic Nitrates are shipped

from two producing locations—Buffalo, New York and Marcus Hook, Pennsylvania. Metallic nitrate solutions are shipped in tank cars or tank trucks . . . crystals come to you in lightweight polyethylene-lined drums.

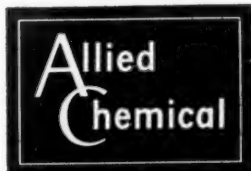
#### **A complete line!**

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**GENERAL CHEMICAL DIVISION**  
40 Rector Street, New York 6, N. Y.

Semiconductor SiC was in the news two years ago when General Electric announced that a silicon carbide rectifier had operated at temperatures up to 1,200 F. Silicon rectifiers, in contrast, have a top limit of 500 F. Commercialization of the SiC rectifier, says GE, must await development of associated circuitry which can match the high-temperature performance of the rectifier itself.

High-purity SiC can be made by a number of different routes. GE has used a method in which silicon and carbon, charged to a high-temperature furnace, vaporize and condense as SiC crystals in cooler portions of the furnace. Starting materials must be of highest available purity—transistor-grade silicon and nuclear-grade graphite.

Another process, now under development at Stanford Research Institute, involves pulling of SiC crystals from a molten silicon bath. Pure silicon is melted in a carbon crucible. Carbon diffuses into the melt and produces a saturated solution of SiC. From a supersaturated "cool spot" produced by careful temperature control, small SiC crystals can be grown.

### ♦ Alumina from low-grade ores

With eternal optimism, U. S. Bureau of Mines is working on an apparently fresh approach to recovery of alumina from low-grade bauxite ores (laterite) found in Oregon.

If the process proves successful—economically as well as technically—aluminum plants in the Pacific Northwest would have their own local sources of alumina. At present their chief raw material comes from either Japan or the south central U. S.

The Oregon ores analyze 30-35% alumina; 26-34% iron oxide; 2-26% silica. At a probable yield of 82-87% of the alumina in the ore, it would take 4 tons of ore to produce 1 ton of alumina. High-grade bauxite, in contrast, yields 1 ton alumina for each 2 tons of ore.

Among aluminum companies in that part of the country, Harvey Aluminum is the most interested, but says iron would probably have to be recovered as a coproduct to make economics look good. The bureau points to the added possibility of recovering  $TiO_2$  from the slag left after iron smelting.

Bureau's process is essentially a double-leach operation. Ore is first calcined at 1,050 C. In a silica leaching step, using 10% caustic at 90 C., 60-70% of the silica is removed. The

alumina leach is then done with 30% caustic at 265 psi. and 210 C. Addition of lime precipitates more silica. The resulting alumina-rich solution can be treated as per the Bayer process to crystallize the alumina.

Caustic soda used in the first leach is regenerated by adding lime to the leach solution.

Work has been on a lab scale so far, but bureau is now running scaled-up tests simulating plant practice. Sufficient economic data are not yet available to judge the process, but bureau engineers feel that economics should be roughly equivalent to the combination process (Bayer process plus red mud recovery, see *Chem. Eng.*, Nov. 1954, pp. 112-114, 334-337).

### ♦ Research and development briefs

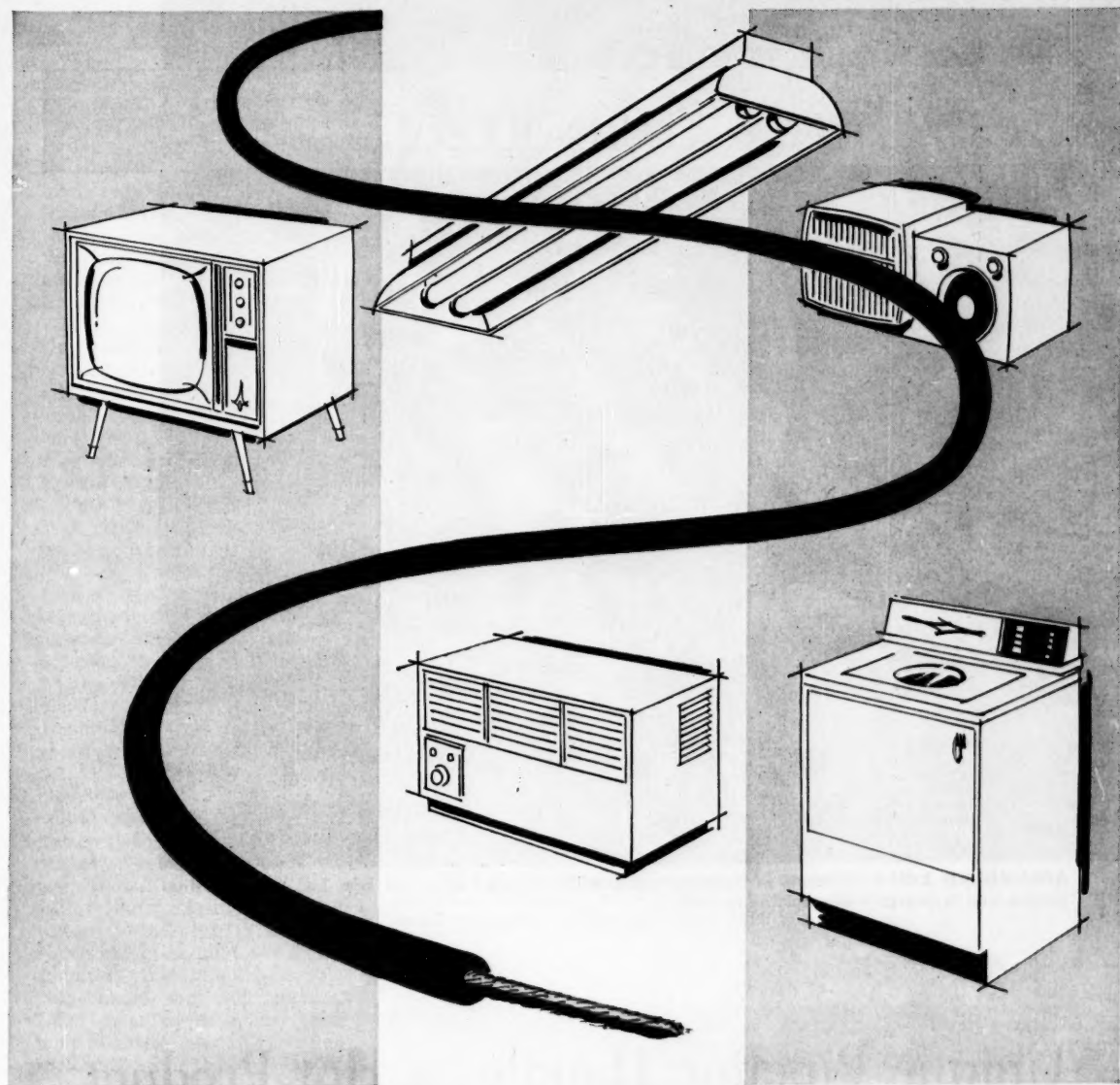
A new wet process for cement may come from studies now under way by Allis-Chalmers engineers. They hope to adapt to wet processing the grate-kiln system now successfully used in the ACL dry process for portland cement. Using a new pilot plant, A-C will also look into methods of controlling alkalis in cement clinker.

Oxidation of oleic acid with air at 200-800 psi. and 110-150 C. with metal catalysts yields a mixture rich in lactone acids. Yield of dibasic acids (such as azelaic and pelargonic, produced by ozone oxidation of oleic acid) is too low to be of economic interest. These findings come from laboratory work done by Stanford Research Institute.

High-power linear accelerators, delivering more energy than currently available machines, are being built by Applied Radiation Corp., Walnut Creek, Calif. One unit will have an energy output as high as 48 kw. It may open up new uses for radiation in chemical processing which have heretofore been judged uneconomical because of limited power.

Catalytic treatment of auto exhaust can simultaneously eliminate the two main smog-contributing components—nitric oxide and unburned hydrocarbons. In work at UCLA on a simulated auto exhaust system, copper oxide at 600-1,800 F. has successfully reduced nitric oxide to nitrogen and oxygen while oxidizing hydrocarbons to  $CO_2$  and water.

**For more on DEVELOPMENTS.....72**



# TRIDECYL ALCOHOL

**To make DTDP—new low cost plasticizer for high temperature vinyl insulation**

Enjay Tridecyl Alcohol is a basic ingredient of ditiidecyl phthalate (DTDP), a new high performance plasticizer developed by Enjay Laboratories. DTDP is ideally suited to the manufacture of high temperature vinyl insulation for the electrical industry. The use of this plasticizer will substantially reduce costs at no sacrifice in electrical and mechanical properties. Enjay does not make ditiidecyl phthalate but supplies Tridecyl Alcohol for its manufacture.

**EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY**

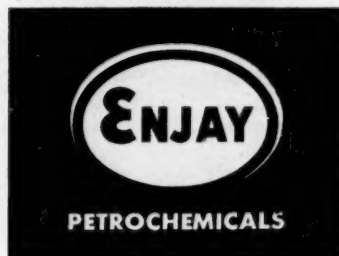
**ENJAY COMPANY, INC.**

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CHEMICAL ENGINEERING—September 7, 1959

**For further information**  
about Enjay Tridecyl Alcohol, write  
or call our nearest office for a copy  
of Technical Bulletin No. 20.



DEVELOPMENTS . . .

## PROCESSES & TECHNOLOGY C. S. CRONAN



ASSEMBLED 2,000-ft. sections of multiple pipeline lie on racks at Grand Isle, La., awaiting final joining and laying of 7-mi. pipeline in Gulf.

## Unique Pipeline Handles a Hot Product

Stretching seven miles on bottom of Gulf,  
multiple-pipeline bundle solves tough sulfur-handling problem,  
extends design experience into new areas.

Classed as a "first-time-anywhere project," a new hot-product pipeline is now in place on the bottom of the Gulf of Mexico at Grand Isle, La., five months after start of construction.

Early next year, pipeline will start delivering up to 4,500 long tons/day of molten 300-F. sulfur

from new Freeport Sulfur Co. offshore mine to inshore barge-loading terminal.

Before now, no one ever has transported sulfur underwater. In order to pioneer such transport, Freeport undertook an engineering job that, by all odds, is the toughest it has ever handled, according to Dewitt Mor-

ris, manager of central engineering dept. That's because the usual problems of handling the product properly were complicated by major structural problems somewhat akin to those encountered by bridge builders. (For another Freeport engineering achievement, see pp. 145-152).

► **Why Use Pipeline?**—At first glance, you wonder why Freeport chose to invest \$2 million in 7 mi. of pipeline just to deliver molten sulfur from the offshore mine to barges at an inshore terminal. Why not load the barges at the mine and avoid this large investment and the engineering headaches involved in building the pipeline?

Well, you'll have to credit Gulf weather with scuttling offshore barge loading. Occasionally, rugged weather at the offshore site may extend over periods of weeks, halting loadings and forcing shutdown of Frasch mining operations.

However, studies indicated that costs were favorable for building and operating a pipeline. So Freeport cast its lot with a pipeline to assure uninterrupted operation. But it's a pipeline unlike any ever seen before.

► **Composite Bundle**—From the pictures on these pages, taken during the recent construction, you can see that the pipeline actually is several pipes assembled into one bundle.

Innermost 6-in. O. D. Jalloj line will carry up to 470 gpm. of molten sulfur entering at 900 psig. This line lies inside 7½-in. Jalloj line carrying 325-F. hot water to maintain sulfur between 320 F. at inlet and 280 F. at outlet. Water flow may vary between 15 and 100 gpm. at 1,400 psig. to maintain these temperatures as sulfur flow varies.

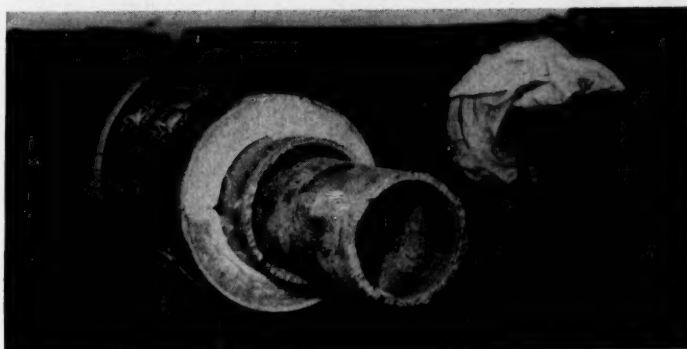
Ball-bearing tandem rollers, spaced 90-deg. apart around outside of water pipe at 19½ ft. intervals, support the weight of sulfur and water pipes inside 14-in. O. D. outer casing.

Exterior of water line has 2½-in. layer of calcium silicate insulation covered with laminated aluminum foil and paper. Pieces of special ¾-in.-thick high-efficiency calcium silicate insulation lie under each roller support on surface of water pipe.

Water discharging from inshore end of 7½-in. line will be cooled to atmospheric temperature and returned to mine through 4½-in. line strapped to the outside of 14-in. casing. To



**HOT-WATER** pipe gets layer of insulation before insertion into casing.



**SECTION** of assembled pipeline contains 6-in. molten sulfur pipe (center) which lies inside 7½-in. hot-water pipe. Rollers supporting these two pipes inside 14-in. outer casing protrude through insulation.



**RETURN-water** and fresh-water lines, banded to casing, complete pipeline.

(Continued on p. 74)



**OFFSHORE**, the pipeline will run to three-legged terminal structure (foreground), rise above surface and cross to the water-heating plant close by.

prevent corrosion and scaling, quality of this water is kept high and water is reused over and over.

Also strapped to the outside of the 14-in. casing is a cement-lined 6½-in. O. D. line that supplies a limited amount of fresh water to the offshore rig for domestic and general service use. Frasch mining operation uses only salt water.

► **Delivering the Bundle**—Composite pipeline was constructed in 2,000-ft. sections and stored on racks (see photo) prior to laying operation. At that time, each section was welded to section ahead and pulled into trench on bottom of Gulf by winches on off-shore barges.

Pulling was facilitated by roller assemblies on launching ramp, by five side-boom tractors stationed along the section and by air-filled buoy pipe which reduced underwater weight of section from 150 to 9 lb./ft.

Once in place, outer casing was placed under 10,000-psi.

tension before filling trench. Shortly before sulfur and hot water lines go into service, they will be heated to about 225 F. to expand them lengthwise some 35 ft.

In this expanded condition, each end of these lines will be fastened permanently to outer casing. At final 300-F. operating temperature, these inner lines will be in compression; there will be essentially no longitudinal movement of pipeline and, thus, no need for expansion joints.

► **Many Stresses**—At operating temperature, compressive stress is 60% of yield strength; at atmospheric temperature, tensile stress would reach about 70% of yield strength.

Other than thermal stresses, design allowed for high pressures and temperatures; bending stress from weight of lines and contents; bending stresses from laying; stress from partial catenary suspension over a soft bottom section.

## Process Plusses Claimed In Making Plastisol Fuel

In unveiling technical data on its solid rocket fuel, Arcite, Atlantic Research Corp., Alexandria, Va., last month listed a number of interesting engineering points in making the aluminized plastisol propellant.

Now in production at a rate of about 20,000 lb./mo., Arcite contains aluminum particles mixed with polyvinyl chloride and ammonium perchlorate oxidizer. Aluminum particle size ranges from 6 to 20 microns; PVC particle size is about one micron.

Though other plastics may have advantages as fuels, the company chose PVC because of its established plastisol technology and production capacity. ARC's manufacturing process begins with commercial paste-grade PVC.

► **Advantages Accrue**—Plastisol process, ARC points out, boasts advantages over those used to make other solid fuels. Temperature control is easier since route does not depend on chemical reactions to convert raw mix to finished rocket charge. Long pot life (time for raw mix to set solid) of about 30 days leaves ample opportunity to check mix quality before taking the next step. Yet fast curing times make practical processing short.

Though aluminum's high heat of combustion nominates it as a solid-fuel component, ARC had to solve one key problem (*Chem. Eng.*, Aug. 10, 1959, p. 56). Thermodynamic calculations based on conventional stoichiometric proportions of about 80% oxidizer, 10% binder and 10% aluminum show that water dissociates at higher temperatures, absorbing, as a consequence, heat released by oxidation of aluminum.

By adding aluminum in "massive" proportions—about 20%—ARC builds an "omox" (only metal oxidized) system. Combustion products are CO (carbon is here considered as a metal), H<sub>2</sub> and Al<sub>2</sub>O<sub>3</sub>. There's no water to dissociate and the temperature ceiling is lifted. Theoretical flame temperature of Arcite is about 5,600 F.

## **PRODUCTION DOLLARS WORK HARDER FOR YOU WITH IBM DATA PROCESSING**

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DATA PROCESSING

# **COST CONTROL**



INTO this computing center flow data from tests on large commercial heat exchangers.

## Computer Pays Out in Exchanger Studies

Here's proof that a digital computer can reduce the cost of making a long engineering study. And it can lift the entire research program.

Hitching an electronic digital computer to engineering studies can save money as well as engineering man hours, according to Senior Engineer J. Albert Curran of C. F. Braun & Co., Alhambra, Calif.

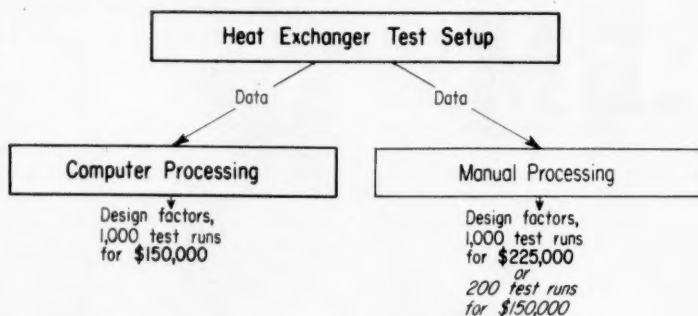
Curran's opinion is based on solid proof obtained in processing data from test runs on big commercial heat exchangers. Now well along on a 1,000-run project started last December, Curran finds that the computer returns far more per dollar spent than does manual data processing.

Behind the obvious gains (shown on the right) are some other not-so-obvious benefits. With no change in the over-all research budget, Braun can undertake additional projects. And they can be completed faster. Furthermore, possibilities are

now better for undertaking research programs that formerly were deferred because they required laborious and costly calculations.

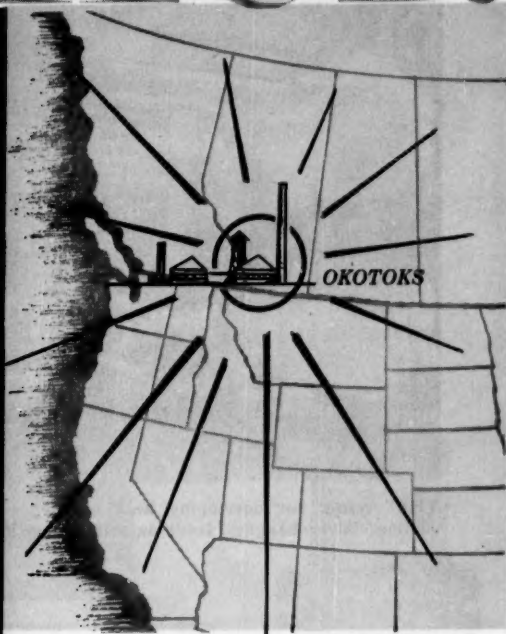
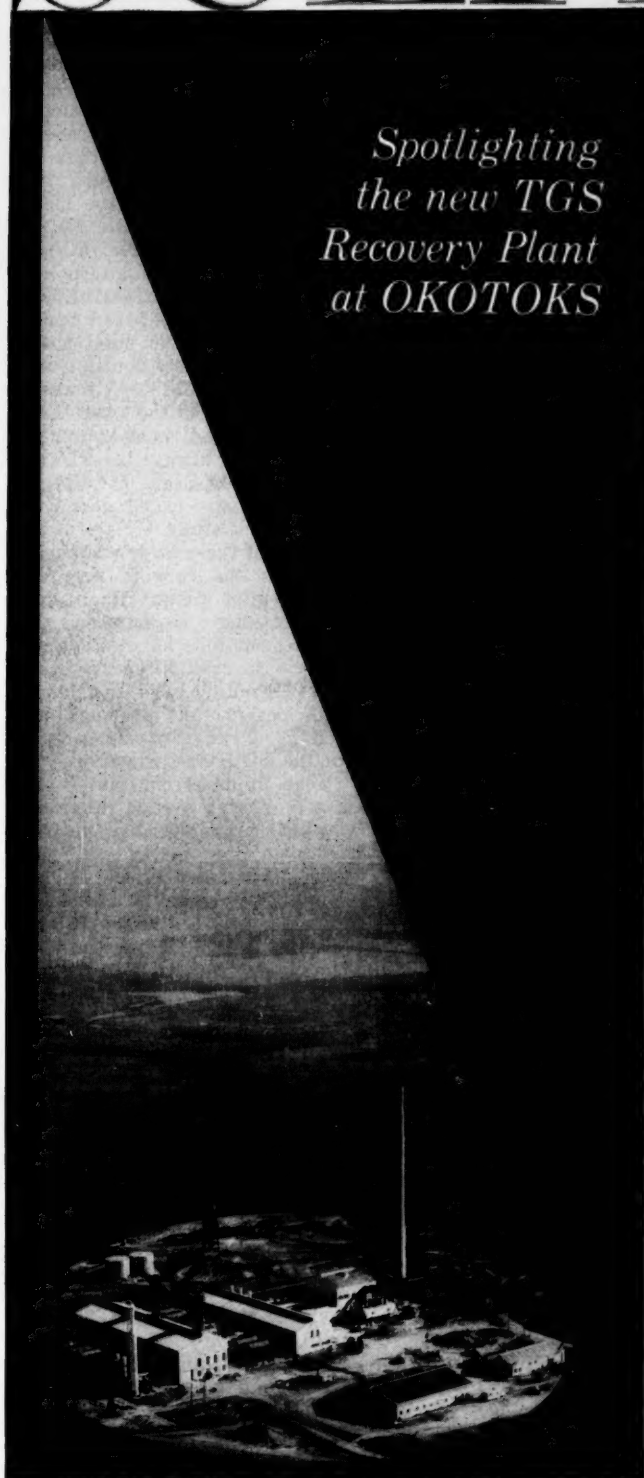
► **Compare These Facts** — But how does Braun's present study break down to give such definite savings? After all, computers are high-cost machines whose

### Computer Saves \$75,000 on Engineering Study



# SULPHUR

*Spotlighting  
the new TGS  
Recovery Plant  
at OKOTOKS*



OKOTOKS marks another step in the steadily broadening service being developed by TGS for industries in the States and Canada. Production from OKOTOKS, sitting on top of the vast "sour gas" field a few miles south of Calgary, Alberta, will add a significant tonnage to the supplies of Sulphur already available through TGS to the expanding industries in the Pacific Northwest. OKOTOKS is set up to make shipments of Sulphur in solid or molten form.

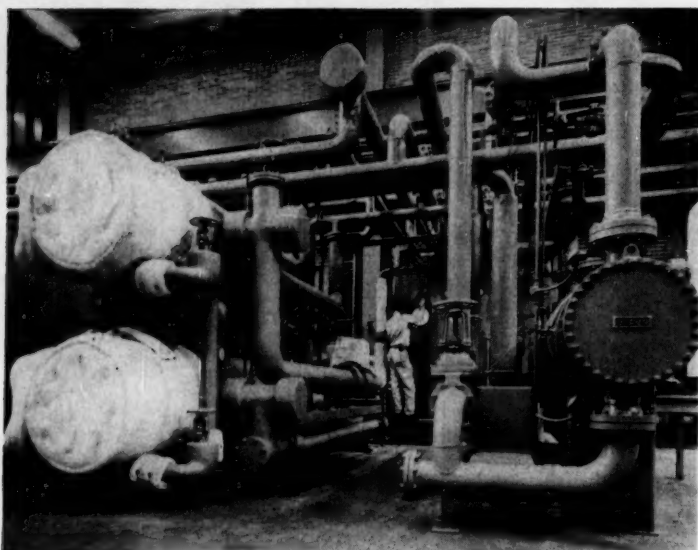


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TEST center for developing heat exchanger design factors uses large commercial exchangers, feeds data to computing center.

hourly charges range from 10 to 50 times the hourly rates for engineers. And computer programming takes many man hours.

In order to break even, engineering man hours saved must compensate for the costs of setting up the program and using the machine. At Braun, Senior Research Engineer J. E. Diehl spent 100 hr. preparing the computer program. Then to set up the program, Data Processing Engineer J. M. Chenoweth took another 550 hr. analyzing, coding and debugging.

Each 5-min. run on the computer involves 90,000 operations. To process data from 1,000 heat-exchanger runs will take 83 hr. total machine time. Charging out this time at 10 times the hourly rate for an engineer means that it is equivalent to 830 man hours.

If these equivalent man hours are added to the 650 hr. spent in setting up the computer, it totals 1,480 hr. Compare this with 8,000 man hours required for doing hand computations and you get a saving on charges for 6,520 eliminated man hours.

► **What Braun Seeks**—Braun's present study deals with design factors and fluid properties that

affect shellside heat-transfer coefficient and pressure drop.

In essence, it's part of the designer's eternal over-all problem of trying to increase heat-transfer rate so that he can reduce size and cost of the exchanger without undue pressure drop and increase in size and cost of pumps. Or, in other words, balancing cost of the exchanger against capital and operating costs of pumping.

Specifically, this study covers runs using various types of cross baffles installed normal to the tubes to increase velocity and cross-flow.

Each type and arrangement of baffles changes the way the flow shortcircuits through clearances between baffles and shell, tubes and baffles and tube bundle and shell. And for each there will be different heat transfer and pressure drop values. Through its study, Braun will increase its knowledge of these relationships in order to improve design and rating methods and establish the basis for new design standards.

► **Computer Opens Bottleneck**—Millstone around the neck of progress in carrying out such research has been the great length of time for processing

data by hand after any test series. Since information produced by processing data affects how subsequent runs are made, the over-all program moves slowly without a computer.

Now, with the digital computer, Braun's group saves so much time and expense that it can conduct many more runs than formerly. Thus, the men no longer have to settle for a few points on a curve, filling unknown area with interpolations and extrapolations. Also, the slack period between tests is shortened to the point that the project is now continuous.

► **Study Big Units**—Because earlier experiments showed that data from small heat-exchangers could not always be extrapolated reliably, Braun uses large commercial-size exchangers for its research study.

Three of these large exchangers form the core of the research pilot plant. Each exchanger has a number of replacement tube bundles. These provide several different tube-field layouts, tube spacings, baffle designs and spacings, as well as a range of clearances for the shellside parts.

Test fluids—from diesel oil to air—having a wide range of physical properties are heated by steam or cooled by water on the shellside of each test bundle. Readings of pressure, temperature and flow are channeled to the data-processing center on special forms.

Heart of the data-processing center is a Burroughs 205 Datatron general-purpose digital computer. With its magnetic drum assembly, this unit can store 4,000 words of information in main storage and 80 words on four bands of high-speed storage.

Handling about 300 computing operations per second, this machine runs through 90,000 operations for each run in 5 min. Final answers include over-all heat-transfer coefficient, tubeside coefficient, shellside coefficient, total heat transferred, pressure drop and dimensionless numbers. Once evaluated and correlated, these data will improve design and rating methods.

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Dirty Lines or Dirty Steam:

Lowest Initial Cost per pound capacity:

Lowest Initial Cost per pound weight:

Eliminating Large Volumes of Air:

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Pulsating or Widely Varying Pressures:

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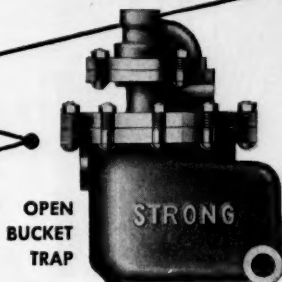
Draining a line carrying a vacuum discharging to atmosphere:

Draining a line carrying a vacuum or very low pressure discharging against a hydrostatic head or back pressure:

**HYDRO-FLEX INVERTED BUCKET TRAP**



**FLOAT & THERMOSTATIC TRAP**



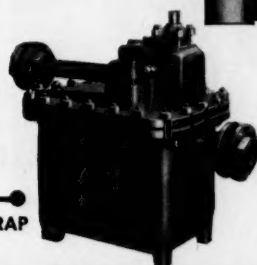
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**STRONG steam traps**  
**give you longer life,**  
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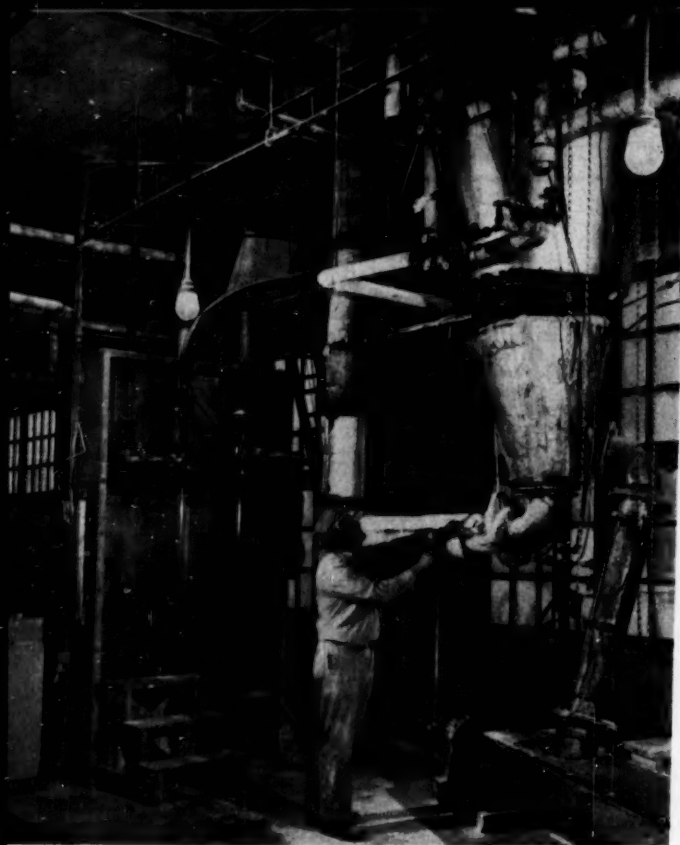
Selector Chart in Strong Catalog No. 69A gives trap recommendations for 45 types of equipment. Write for your copy or call your distributor.



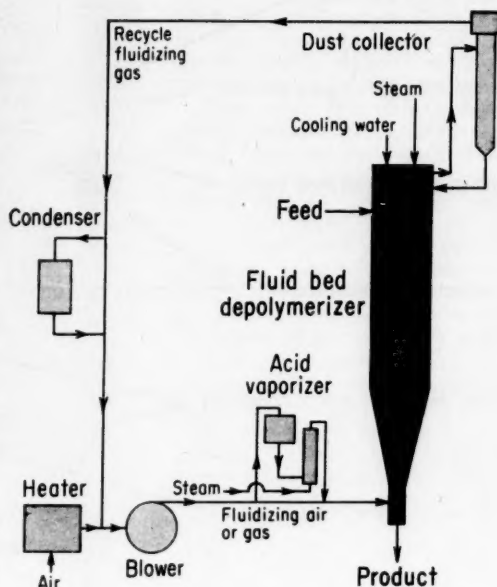
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steam traps • air traps • float traps • vacuum or pumping traps  
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DEPOLYMERIZER discharges out bottom into conveyor. Acid vapor enters depolymerizer from apparatus on left.



## New Approach Speeds Depolymerizing

Pioneer effort defies natural law,  
heats powder in process as easily as heating water,  
slashes investment and operating costs.

According to Stokes' law, you can't fluidize starch. But Ralph Frederickson refused to believe it. And out of that refusal came a new process that depolymerizes corn starch to dextrins with unheard-of ease.

Ralph Frederickson is engineering research chief at A. E. Staley Mfg. Co. Over the past 5 yr. he has directed Staley's attempts to circumvent Stokes' law.

Today these efforts are paying off. At Staley's Decatur, Ill., plant the first commercial

fluid-bed dextrinizer in the U. S. A. is converting 10,000-lb. batches of corn starch to over 50 different dextrin products.

Moreover, Frederickson reports that the unit has chalked up a striking list of processing advantages:

- Converts four times as much starch in one-third the time as do jacketed-pot or mixer-type dextrinizers of equivalent capacity.
- Takes only one-eighth as much floor space as older equipment.

- Costs only 20-25% as much initially.

- Requires less operating labor, maintenance and fuel.

- Produces superior-quality products.

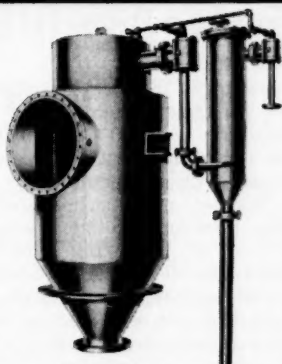
► **Clean Breakthrough**—To achieve such outstanding gains, Frederickson's group built a new technology where an art existed.

Conversion of starch to dextrin is actually a depolymerization by heat, in the presence of an acid catalyst, which reduces viscosity and increases tacki-

# Nulli Secundus!



Graham 6 stage ejector capable of maintaining 4 microns absolute and handling 40,000 cu ft/min.



Graham direct contact condenser and 2 stage ejector—all of stainless 304 material.



Single stage jet used on a 2 stage evaporator functioning as a thermo-compressor.

Thank you, Brutus, old boy, for the right words! And, just as you say, the Graham Steam Jet Ejector is "second to none".

We have recently completed an extensive development program in our Batavia, New York engineering laboratory which has resulted in *added improvements* to the already high performance of Graham Steam Jet Ejectors. Design refinements worked out in this investigation mean increased stability, dependability and economy.

We now offer you the *finest performance available* from one to seven stages—a few inches of vacuum down to one micron of absolute pressure—evacuating small or large loads. Yes, Graham Ejectors are truly "second to none".

More information is contained in our Bulletin No. 70A. Send us your inquiries.

**GRAHAM MANUFACTURING CO., INC.**



**Heliflow Corporation**  
170 GREAT NECK ROAD, GREAT NECK, N. Y.  
Offices in principal cities and Canada

ness of the material for end use as adhesive.

Ideally, it's possible to carry out this depolymerization within 30 sec. Actually, the conventional batch process takes 3 to 24 hr., depending upon the type of dextrin being produced.

This spread between ideal and actual offered a broad target for a breakthrough and Fredrickson proceeded to capitalize on it.

It was evident that long process cycles stemmed from the poor heat-conducting properties of the starch granules. Less evident was the need to maintain a slow heating rate to permit adequate venting. Otherwise, moisture driven from the starch condenses on cooler starch granules and produces a "taffying" effect.

► **Fluidizing Paradox**—To overcome these problems and narrow the gap between theoretical and commercial depolymerization, Fredrickson looked to fluidization. But the first look revealed a seemingly hopeless paradox.

What better way to speed up heat transfer to relatively non-conductive solids than by fluidizing them? And the fluidizing gas also could speed up venting of moisture from the mass.

But what good was this speculation when calculations indicated that, theoretically, starch can't be fluidized, based on Stokes' law?

According to Stokes, even the largest starch granule would settle in air no faster than 0.056 ft./sec. So Fredrickson could expect air velocities above this value to blow the starch out of the fluidizing vessel.

Luckily, this didn't prove true. First on a laboratory scale and then on a semi-commercial scale, fluidizing worked well without conveying any undue amount of starch from the vessel, even with gas velocities 10 times greater than the Stokes maximum.

► **Big Jump in Flux**—Furthermore, in the fluidized state, starch could be processed with a much higher heat flux than with conventional equipment.

In the first place, heat transfer coefficient is about 40 Btu./hr./°F./sq. ft. Then, this high

coefficient is utilized more fully by ability to use about 8 sq. ft. of heating surface in the fluid bed for each 100 lb. of starch, or roughly double that commonly employed.

► **Tall and Skinny**—After completing semi-commercial work to establish these facts, Staley constructed the 10,000-lb. unit which recently went into operation.

It stands roughly 25-ft. tall. Upper 12-ft. section is 6-ft.-dia. stainless-steel cylinder. Lower 13-ft. section tapers from 6-ft. dia. at upper end to 8 in. at the bottom.

Some 15-20 plate heat-exchange coils, measuring 18 in. long by 8 in. wide, are arranged vertically in fan configuration within upper cylindrical section. Cone on bottom is jacketed externally.

► **Blow**—To start batch, operators charge 8-10,000 lb. of 5-10 micron corn starch particles through hopper into top of fluid-bed dextrinizer. Air from 800 scfm. blower enters through ½-in. holes in plate located at apex of cone on bottom.

► **Heat**—Once the air has fluidized the charge, 150-psi. steam is fed to the plate coils. Within 20-30 min., charge has reached desired dextrinization temperature between 150 and 350 F.

► **React**—Then HCl vapor, produced by tantalum bayonet heater in 6-in. dia., 5-gal. glass acid reservoir, is introduced into air duct. Flowing up into fluid bed with air, acid is absorbed uniformly by starch granules.

Depending upon the dextrin product being made, depolymerization reaction takes from 1 to 8 hr. If desired, reaction can be stopped by killing acid catalyst with ammonia vapor in air stream.

► **Finish**—Whether or not ammonia is used, the streams of acid vapor and steam to the heaters are shut off. Cooling water enters the plate coils and bed drops to room temperature within 10-20 min.

If a particular dextrin product requires additives, such as borax, these can be introduced to the fluid bed after cooling. Or steam can be fed in with air to restore moisture to dextrin.

Then material is withdrawn through gravity-discharge opening to blender or final packaging line.

In special cases, processing under inert gas may be desired. This is done by recycling the fluidizing gas.

## New Approach to Make High-Purity Thorium

Using a modified Kroll process, U.S. Bureau of Mines at Albany, Ore., is taking a new approach to making high-purity ductile thorium. Bureau is now turning out 50-lb. batches of sponge in scaled-up operation which involves sodium reduction of thorium tetrachloride.

New process turns out higher purity metal (99.8% thorium) containing smaller amounts of impurities than thorium made by conventional methods.

Process works this way: Thorium oxalate is chlorinated with carbon tetrachloride to produce crude thorium tetrachloride; this is purified by vacuum distillation in nickel equipment.

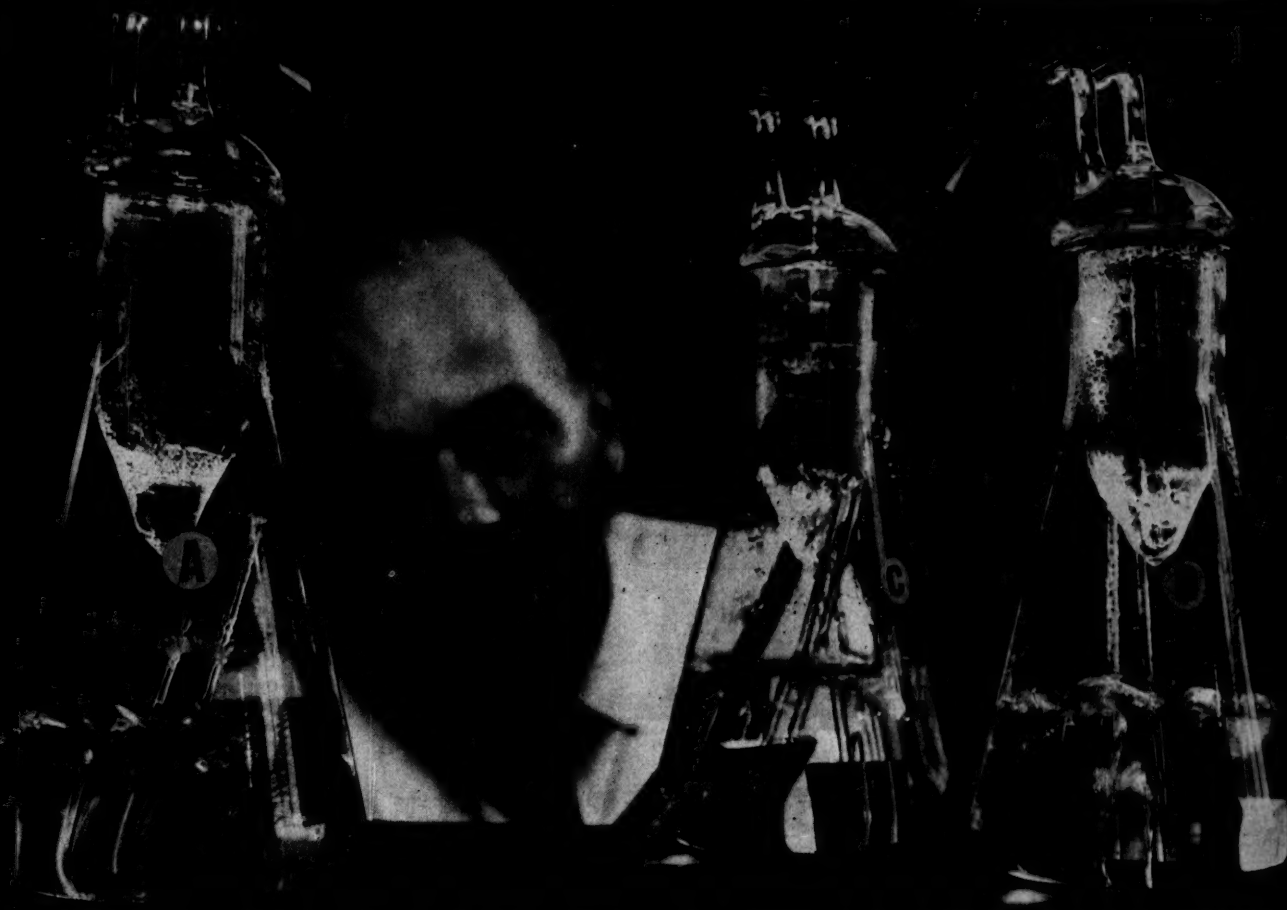
Purified chloride is reacted with sodium in inert atmosphere in a titanium crucible. Reaction starts at a temperature of 300-400 C., is completed by heating to 850 C.

Retort is then evacuated and sodium chloride and excess sodium are distilled off at 900 C. under high vacuum, leaving high-purity thorium sponge.

Biggest problem remaining, says Bureau, is to improve technique of preparing thorium tetrachloride, presently made in small batches. Materials of construction are expected to be a major problem in design of a continuous chlorinator.

## Will Plutonium Outmode Uranium Nuclear Fuel?

Taking one more step toward economic nuclear power, United Kingdom's Atomic Energy Authority last month put into operation its first power-producing, plutonium-fueled fast-



# "How Jessop Tests Stainless Steel in Boiling Nitric Acid"

L. W. Cooper, Chief Metallurgist

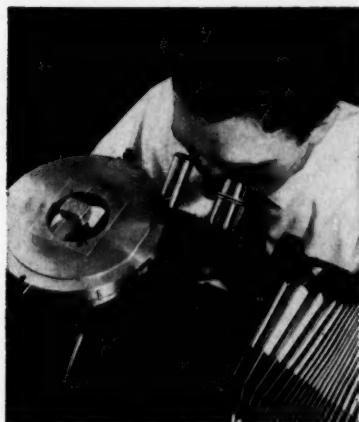
"From experience, our customers know this is a fact: Specify Jessop for specialty steels . . . and then relax! Of the many reasons *why* this is true, here's one . . .

"In evaluating corrosion resistance, one of the procedures we use is the ASTM boiling nitric acid test. Standard and simple? Yes. But expert *evaluation* is of great importance to the

customer. That's why, at Jessop, a top metallurgist closely supervises each of the five 48-hour test periods.

"*Overly cautious?* Because we're overly cautious in *every* phase of steel production and quality control, Jessop has earned the reputation for producing specialty steels tailor-made to the most exacting specs—*Specify Jessop . . . and then relax!*"

Here, boiling nitric acid is used to evaluate the corrosion resistance of Jessop stainless steel plate.



Checking the grain size of tool steel, this Jessop metallurgist uses a microscope with a camera attachment.

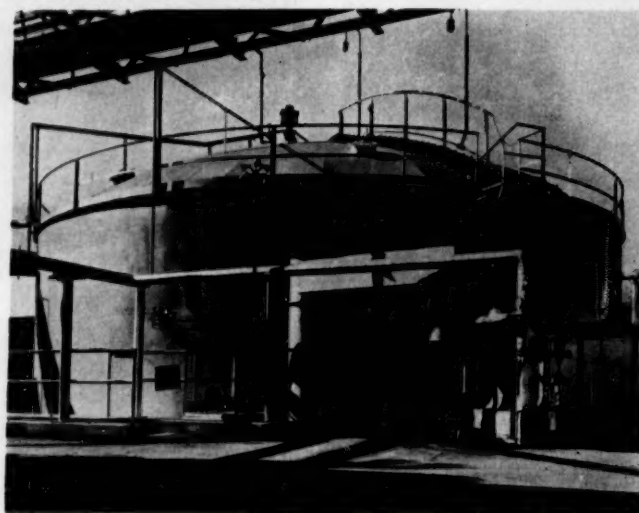
VMA 6787

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Steel Warehousing Corporation, Chicago

**JESSOP**  
STEEL COMPANY  
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Stainless, alloy, tool, cast-to-shape, clad, and forging steels, ground flat stock and other specialty steels



### Storage Tank Contains Liquid Oxygen at -300 F.

Built and fabricated by Chicago Bridge & Iron for McLouth Steel Corp. at Trenton, Mich., this specially insulated, double-wall storage tank holds 160,000 gal. (about 800 tons) of liquid oxygen. Inner tank is stainless

steel, 40-ft. dia., 17 ft. high. Outer carbon steel tank is 52 ft. in dia., 28 ft. high. Inner tank sits on 6 ft. of foamglass; other spaces between tanks contain perlite. Oxygen loss is held to a minimum.

breeder reactor. UKAEA's chairman, Lord Plowden, predicts eventual uranium oversupply and consequent drop in uranium price to \$8/lb. by 1965.

Here in the U.S., research at Argonne National Laboratory's new plutonium research laboratory aims at development of plutonium fuel elements. And Vitro Engineering Co., New York, N. Y., is designing a plutonium research laboratory for Oak Ridge National Laboratory. At the Hanford Works, construction is now under way on a similar laboratory to study plutonium in the liquid phase.

All these efforts point toward eventual utilization of plutonium-239, recovered during the reprocessing of irradiated fuel elements.

### Two Midwest Meetings Probe Process Control

The Midwest will monopolize process control during the weeks of Sept. 20 and 27 in two important meetings. Starting Sept. 21, the Instrument Society of America opens a week of technical meetings and exhibits in Chicago. And the following week, AIChE will have a three-day meeting in St. Paul that includes an all-day session in process dynamics and control.

The afternoon of Sept. 21 at the Palmer House, ISA will kickoff sessions of interest to CPI engineers with a control-systems workshop—a panel and discussion session on applications of controls in plant design.

Sessions later that week (all at the Palmer House) will include final-control elements (Thursday), primary-measurement elements (Wednesday morning), communications needs for process systems engineers (Wednesday afternoon), use of computers for process control (Wednesday afternoon) and others.

On Tuesday (Sept. 29) in St. Paul, eight papers on control will cover such topics as automatic pressure and flow-control system design, dynamic response of shell-and-tube heat exchangers to temperature disturbances, dynamics of control of absorption columns, and use of an analog computer for on-line control of a chemical reactor.

### NEWS BRIEFS

**Rocket insulation:** Astrodyne, Inc., has developed a new lightweight rubber-asbestos insulating material considered by Navy Bureau of Ordnance to be a major technological breakthrough. In tests, insulation has resulted in successful firings of solid-propellant rocket motors with significant thrust for durations of over 3½ min., a 3-4-fold increase over present solid-propellant motors.

**Test reactor:** Westinghouse water-moderated and cooled test reactor has gone critical at Waltz Mill, Pa., at an initial power level of 20,000 kw. (heat). Prime purpose of reactor is to test materials and fuels under radiation conditions similar to those of operating power reactors (see *Chem. Eng.*, Dec. 1, 1958, pp. 66-70).

**Ethanolamine route:** Soviet engineers have developed a commercial continuous process for ethanolamines. Process involves reacting ethylene oxide with excess anhydrous liquid ammonia at about 120-130 C. and 1,400-1,500 psi. As ammonia-to-oxide ratio decreases, yield of di- and tri-ethanolamines increases.

# SAFETY SWITCHES STAND UP UNDER 100,000 AMPERE SHORT CIRCUIT TEST!

## INDEPENDENT TESTING LAB RELEASES FINDINGS AFTER GRUELLING "TORTURE RACK" TESTS

Unprecedented tests have been completed on 30 through 600 ampere rated Square D safety switches equipped with high capacity current limiting fuses. During these tests, switches were closed on a short circuit system delivering up to 100,000 amperes (symmetrical—R.M.S.). In addition, the fault was applied on the closed switches. *All switches withstood the shocks without any sign of failure!*

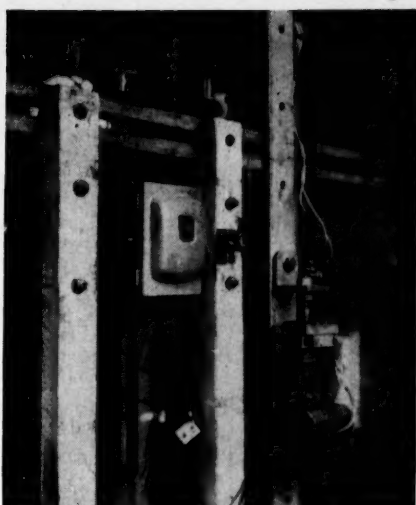
### High Capacity Systems Demand Stamina

High capacity systems capable of delivering tremendous short circuits are becoming more and more prevalent with the growth of electrical loads. Network systems in metropolitan areas are a source of

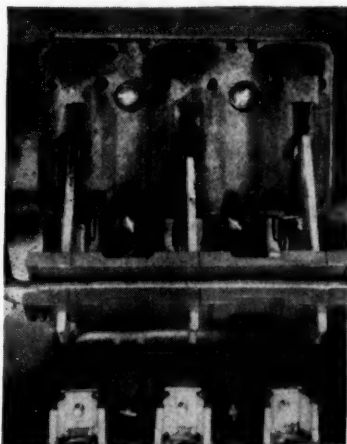
such faults. Another, the heavy industrial areas, with a concentration of sub-stations and rotating machinery. Terrific stresses and heat generated by such faults are serious hazards to both personnel and equipment unless properly contained. That is why proven protection for switching service and feeder circuits is of major concern.

### Square D Standard Switches Do The Job

These tests offer conclusive proof that standard Square D Type HD and Type ND switches, equipped with high capacity current limiting fuses, can be used on such systems without fear of failure. You pay no premium for the proven performance they offer. Why settle for less?



Square D switch on "torture rack" during test involving up to 100,000 ampere short circuit



SUMMARY TABLE • Extract from Report No. 5/NA R66—Sheet No. 5

Ampere Rating	Voltage Rating	Catalog Number	Average Symmetrical Prospective Current R.M.S.	Recovery Voltage R.M.S.	Maximum Total Arcing Time	Fuse Type
30	250	A85351	96,600	252	.0009	A2Y-30A
30	250	A85351	96,400	253	.0010	FRN-30A
30	600	A85341	107,000	590	.0020	A6Y-30A
30	600	A85341	106,000	601	.0027	FRS-30A
60	250	A86352	96,400	248	.0010	A2Y-60A
60	250	A86352	95,200	252	.0019	FRN-60A
60	600	A86342	106,000	605	.0011	A6Y-60A
60	600	A86342	108,000	598	.0020	FRS-60A
60	600	A86342	107,000	601	.0013	NAS-60A
100	250	A86353	95,200	253	.0009	A2Y-100A
100	600	A86343	108,000	504	.0014	A6Y-100A
200	250	A86354	95,200	253	.0037	A2Y-200A
200	600	A86344	107,000	602	.0011	A6Y-200A
400	250	A86355	95,900	252	.0039	A2Y-400A
400	600	A86345	106,000	611	.0050	A6Y-400A
600	250	A86356	94,500	251	.0062	A2Y-600A
600	600	A86346	107,000	601	.0062	A6Y-600A

Above • Extract of Nelson High Power Laboratory Report C/NA-66

At left • No sign of failure in this switch interior after 100,000 ampere short circuit test

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SAFETY  
SWITCHES  
GIVE YOU**

*Certified*

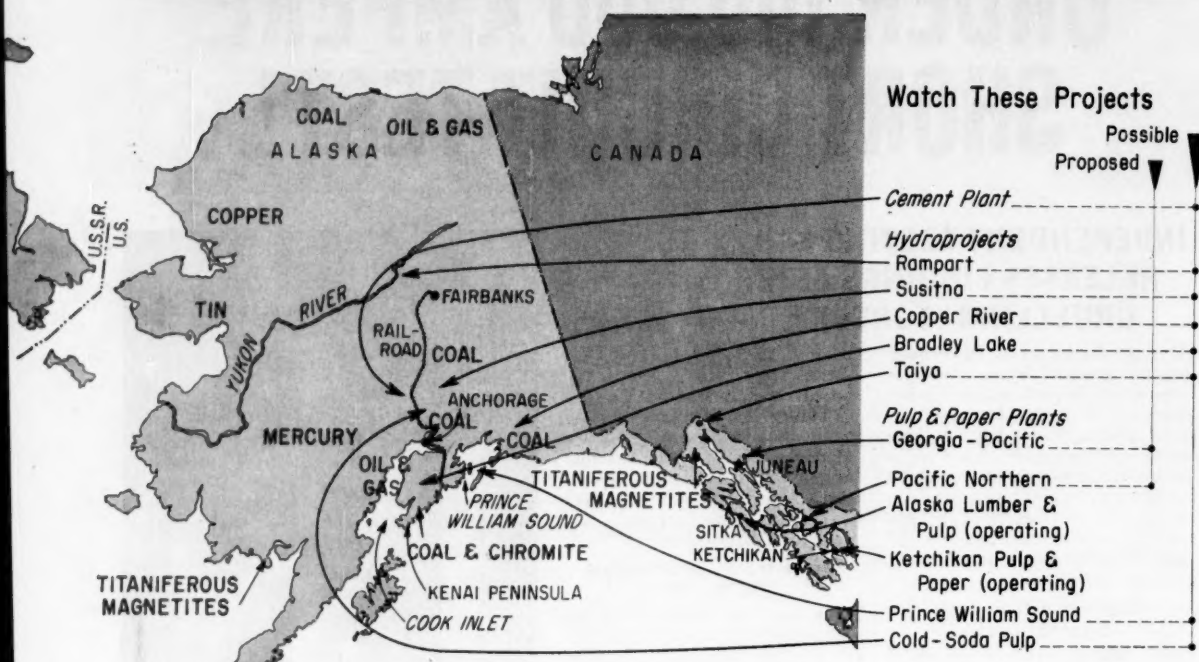
**PERFORMANCE!**



**EC&M** HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE



**SQUARE D COMPANY**



## Alaska's Chemical Future: Full of Ifs

Alaska has a thwarted potential much like that of Canada: Abundant natural wealth—  
if you can get it.

Ivan Bloch, Ivan Bloch & Assoc., Portland, Ore.

Our spanking new 49th state has a great potential for the chemical processor. But that's about all it has—potential. Alaska is no beehive of chemical activity now, nor is it likely to become one for many years.

Alaska's only solid chemical processing industry is pulp and paper, and even that industry isn't big enough to justify a local supporting chemical industry. However, pulp and paper operations are growing rapidly and

offer, at the very least, an attractive target for chemical export from the Pacific Northwest.

Alaska's mineral resources are impressive. Iron ore and coal abound. A cement industry looks likely.

But oil and gas reserves are still of unproved value. And reserves of many minerals are far removed from their markets and from the equipment and materials required to exploit them.

Alaska's modest transportation

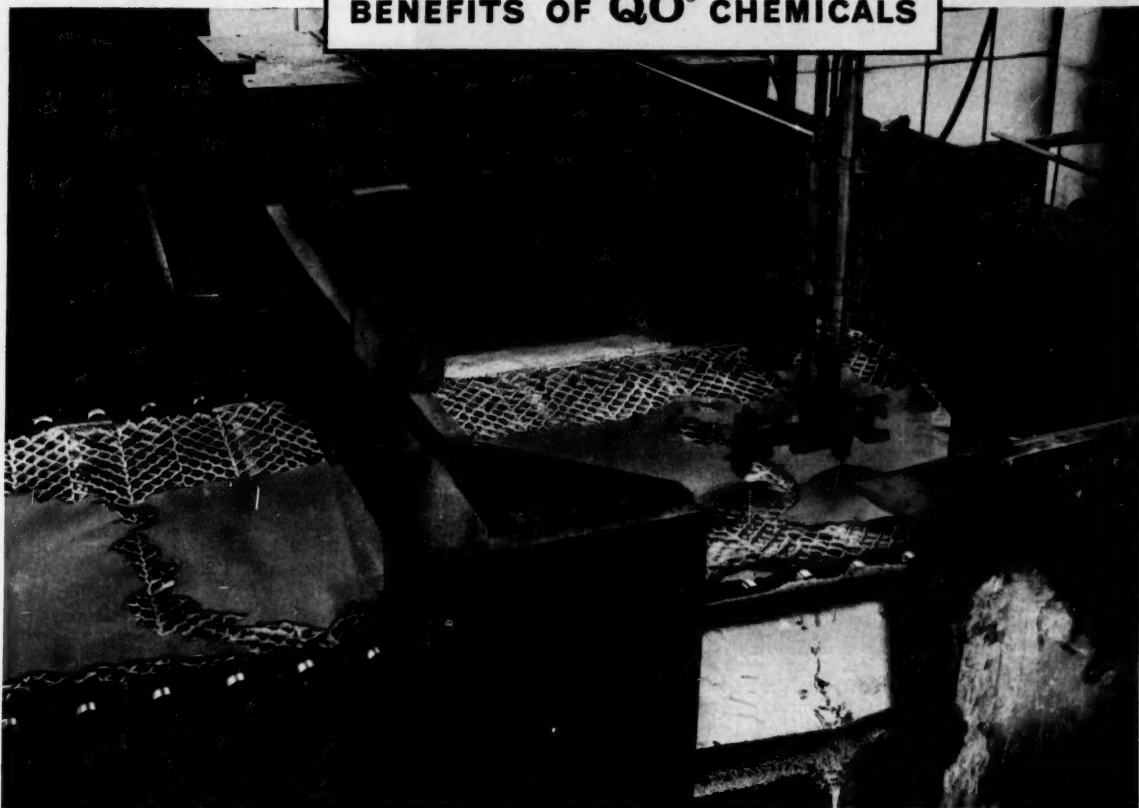
system is largely water-oriented.

Cheap water power, Alaska's great energy lode of the future, is virtually untapped to date.

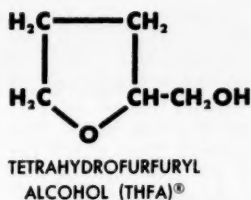
Markets for consumer-directed chemicals are very slim. There just aren't enough Alaskans (about 220,000) to buy very much, although a healthy birth rate should push the population to 750,000 by 1975.

So look at Alaska, not as the scene of massive and sudden chemical investment, but as the

## BENEFITS OF QO® CHEMICALS



### SPRAY-DYE DEEP SHADES USING QO® TETRAHYDROFURFURYL ALCOHOL



QO Tetrahydrofurfuryl Alcohol (THFA) makes possible spray-dyeing of full-grain leather for two reasons. First, QO THFA is an excellent solvent for a wide range of dye types including acid, basic, and direct.

Secondly, THFA is a very efficient driver carrying the dye through the grain of the leather without disturbing the fat liquor balance necessary for flexibility and "feel". The combined action of THFA as a penetrant and dye solubilizer permits spray-dyeing of full-grain leather in deep and even color shades. The depth of color obtained using THFA is equivalent to that achieved in drum-dyeing.

THFA serves as a useful adjunct in flame-coating of corrected grain leather by giving a more evenly dyed undercoat. As a result, fewer pigment-finish coats are necessary thus preserving the true character of the leather. THFA is also used as a penetrant for resin-finish coats to aid resin penetration and adhesion to leather surfaces.

Investigate the advantages of QO THFA in dyeing. Write for a sample and a copy of Bulletin 206. Watch our ads for benefits of QO THFA in other industries.

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ALASKA'S biggest pulp mill: Ketchikan Pulp's rayon-grade plant.

scene of slowly opening opportunities—pulp and paper, water power, markets for Pacific Northwest chemicals—here and there for chemical processors.

► **Pulping Strong** — Southeastern Alaska, the Panhandle, is the scene of major industrial activity these days as the vast forest resources are exploited for production of pulp products. At Ketchikan, the Ketchikan Pulp Co. (a joint operation of Puget Sound Pulp & Timber and American Viscose) has been turning out rayon-grade dissolving pulp since 1952. Capacity has recently been stepped up to what is probably the allowable limit for sustained-yield operations—600 tons/day.

At Sitka, also in the Panhandle area, Alaska Lumber & Pulp is rapidly completing its 400-ton/day alpha cellulose pulp plant. Operations are scheduled to begin in 1960.

► **Japanese Interest** — This chemical pulp plant is the operating arm of Japanese Pulp Co., Ltd., of Tokyo whose stockholders include major Japanese rayon and paper concerns. About a fourth of the \$55-million Sitka plant is financed by U.S. investors, the rest by Japanese.

Another sustained-yield permit has been awarded to Georgia-Pacific Alaska Co. The unit will, if Georgia-Pacific goes

ahead, support a newsprint operation of 500-700 tons/day. Possible plant location: the Juneau-Douglas area.

Still another sustained-yield unit is being considered by Pacific Northern Timber (composed of Pacific Northwest interests). A Forest Service permit specifies an initial 100-ton/day sawmill, and an eventual sulfite pulp newsprint mill with a capacity of some 100 tons/day.

► **Pulping Chemicals** — Thus, pulp and paper operations will continue to provide diversified markets for a number of processing chemicals, especially if Georgia-Pacific and Pacific Northern exercise their full rights under their permits. But it's doubtful that the demand will be enough to justify establishing supporting chemical plants in Alaska for some years to come.

Nevertheless, forest industry development in Alaska is likely to be of major proportions. In the Cook Inlet area are vast resources of birch and other deciduous woods which appear suitable for making a specialty pulp for admixture in the production of toilet tissue and container board.

There should be merit there in a fully integrated operation ranging from logging to pulp production via the cold-soda

(semichemical) process. Annual chemical requirements for a operation rated at 100 tons/day of bleached pulp might run as follows: 10,000 tons soda ash, 2,500 tons sulfur, 7,000 tons chlorine and 1,200 tons caustic soda.

Metallurgical industries in Alaska are basically those entailing beneficiation and initial processing of gold, mercury and platinum. Largest single operation is that of U. S. Smelting, Refining and Mining (Fairbanks Exploration Co.) in Fairbanks and environs.

Since most other metallurgical activity is exploratory, the market for flotation and other treatment chemicals is, on the whole, somewhat limited.

► **Iron and Titanium** — Most interesting of the metallic mineral resources are the titaniferous magnetites. Foremost of these are the Klukwan deposits near Haines. There is activity also in the Snettisham area to the south.

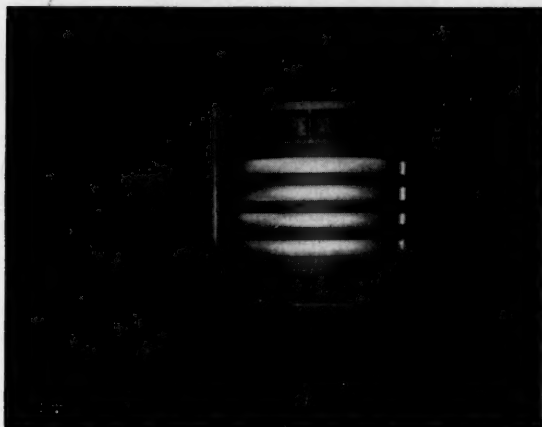
Although a number of processes for production of pig iron and titanium residues have been investigated, electric furnacing seems to be the best bet for the future.

A major pig iron plant will require, however, large quantities of low cost electric power. Proximity of the Klukwan deposits to the proposed Taiya hydroelectric power project augurs well for exploitation of both.

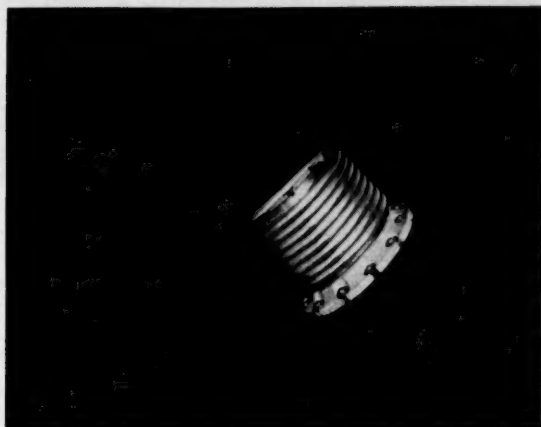
As for low-grade nickel ores in southeastern Alaska, it's far too early to speculate on the scale of development possible. (Relatively high-grade deposits have recently been discovered.) Some nickel ores are high enough in sulfides to suggest production of sulfur chemicals—which might be tied into pulp and paper operations.

► **Electroprocessing** — From time to time, there's been talk of an electric furnace operation on the Kenai Peninsula in the Seldovia-Homer area for the production of ferrochrome (from metallurgical-grade reserves there), ferrosilicon and calcium carbide. Prospects for this will be much brighter if and when work begins on the proposed 30,000-kw. Bradley Lake hydroelectric power project which, according

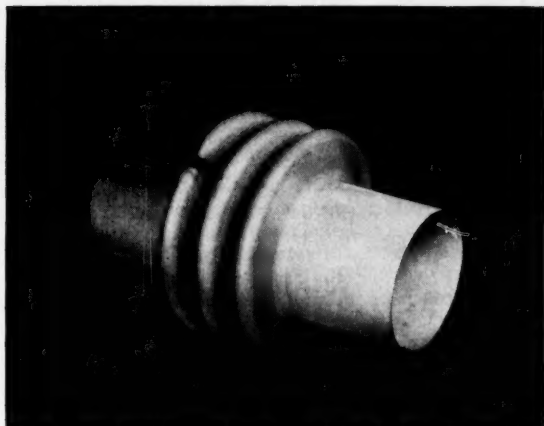
# 4 WAYS to get maximum reliability in expansion joints



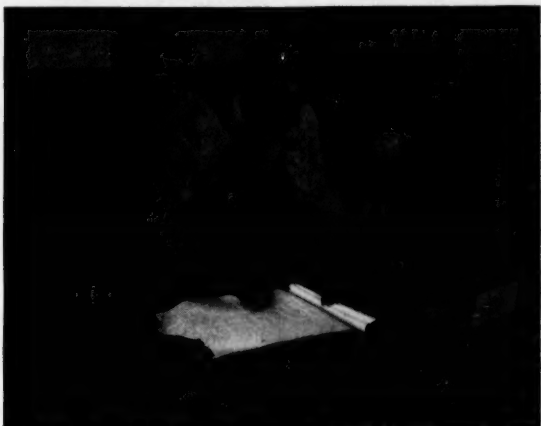
**1** Insist that the corrugated bellows be hydraulically formed. The reason is simple. Whenever bellows are formed by circumferential welding . . . whether by edge, seam or fillet welding . . . they will always be subject to premature failure because of stress concentrations at the welds.



**2** Be sure the manufacturer maintains a continuous and comprehensive program of endurance testing. This is basic, because of the many variables that affect expansion joint life. Accurate determination of expansion joint life expectancy can only be determined by cycling to destruction.



**3** Demand proof that the manufacturer can produce longitudinal welds in the corrugated bellows having the same strength, physical properties and thickness as the parent metal . . . without grinding. A weld that is hard to find is a ground weld. Variations in weld thickness set up points of stress concentration . . . opening the way for premature failure.



**4** Check the ability of the manufacturer to supply a team of *competent* design and application specialists to work with your engineers. Check their specific experience in handling critical, complex applications in your field . . . complete to the record of successes or failures behind them, and details of how this experience will be brought to bear on your problem.

At Zallea, none of the many factors affecting expansion joint reliability are left to guesswork . . . including the four vital ones above.

This is reflected in these facts. Zallea material specifications are the most exacting in the industry. Zallea expansion joints are hydraulically formed. Zallea advanced welding techniques insure welds having the same thick-

ness, strength and physical properties as the parent metal. Zallea has done more cyclic testing to destruction than all government agencies and industrial firms combined. Zallea has produced more expansion joints than any other manufacturer . . . offers more application engineering experience.

For all the facts, write for Catalog 56. Zallea Brothers, Taylor and Locust Streets, Wilmington 99, Delaware.

*Zallea* for maximum reliability

**ZALLEA BROTHERS, Wilmington 99, Delaware • World's largest manufacturer of expansion joints**

## Alaska's Chemical Needs: Still Modest But Mounting\*

	(Tons)	
	1952	1957
Coal tar products.....		298
Fertilizers.....	917	2,080
Nitrogen fertilizers, n.e.c.....	217	382
Sulfur.....		8,133†
Sulfuric acid.....	18	27
Salt.....	1,475	3,190
Pigments, paints, varnishes.....	1,255	4,170
Misc. chemical products.....	1,664	3,447
Industrial chemicals, n.e.c.....	9,462	38,006
Pharmaceuticals.....	82	166
<b>Total.....</b>	<b>15,091</b>	<b>59,899</b>

\* Waterborne chemical shipment to Alaska from the rest of the U. S.; † Shipment from foreign country; n.e.c.: not elsewhere classified.  
 Sources: Adapted from U. S. Corps of Engineers "Waterborne Commerce of the United States Waterways and Harbors, Pacific Coast, Alaska and Pacific Islands" Calendar Years 1952, 1957.

to preliminary estimates, will turn out very low cost energy: 3-4 mills/kwh.

The Taiya, Copper River and Yukon River power projects will undoubtedly stimulate electro-process industrial development, although it's unlikely they will be in operation in less than a decade.

Now let's turn to nonmetallic minerals.

Alaska does not as yet produce its own cement. Total market has been for several years on the order of 300,000-400,000 bbl./yr.—not enough, in terms of standard U.S. practice, to sustain a minimum economic plant operation.

► **Good Limestone** — Interest continues, however, in establishment of a cement plant almost midway between Fairbanks and Anchorage on the Alaska railroad. Foggy Pass limestones appear suitable for cement production; all other materials are available save gypsum, which would have to be shipped in from the outside.

There are a number of concrete plants in the railroad belt at Anchorage and Fairbanks, including a newly established pre-stressed-concrete-products plant. There's renewed interest, too, in utilization of expanding shales for lightweight concrete aggregate.

Alaskan oil and gas development—and with it a petrochemical industry—is a possibility. But until reserves are more

clearly defined and commercial possibilities more clearly established, it's difficult to augur any major breakthroughs along these lines. If the Kenai Peninsula reserves are large enough, a small refinery complex might be set up for the production of local fuels.

Processing of Alaska's vast coal resources (estimated in excess of 100 million tons) offers some interesting, but as yet speculative, avenues of approach.

► **Coal Chemicals?** — For example, coal mining in the Nenana fields about 100 mi. south of Fairbanks will probably range between 500,000 and 750,000 tons/yr. in the foreseeable future. This bituminous coal is high in volatiles which, through a low temperature carbonization process, might yield salable chemicals.

The dry char would find markets in steam plants in the Fairbanks area. Tar liquids could be processed to high grade metallurgical carbon (for which substantial and growing markets exist on the West Coast of the U.S. and in Pacific Basin nations); processed to electrodes for West Coast aluminum reduction; and processed to light oils, jet fuel and gasoline for domestic markets in the railroad belt.

Whether other hydrocarbons could be economically produced is somewhat questionable, at least for some years in the future. Production of tars for road surfacing and creosote war-

rants consideration as part of a coal-processing complex. Asphalt is now brought into Alaska and a creosoting plant is planned at Whittier.

West Coast states may share further in Alaska's potential. The high-purity limestones of southeastern Alaska are being evaluated in terms of shipment to West Coast chemical plants. By the same token, magnesiapulp barge movement from the San Francisco Bay area to southeastern Alaska pulp plants is under study. Pulp shipments from Ketchikan to West Coast points are already a reality.

And in the event coals of the Alaska railbelt and Cook Inlet locales are processed, a major portion of the products would be consumed in West Coast tide-water plants.

► **Chemical Markets**—How do Alaskan industries stack up as markets for chemicals?

Her agricultural industry (\$4.6 million in products in 1957) is a small consumer of various chemicals: fertilizers, herbicides and insecticides. Tonnages are moderate, probably not over 3,000 tons/yr.

Processing of food products requires small amounts of chemicals: preservatives and sterilization agents for dairy equipment.

And although Alaska's fishing industry is very large, its chemical consumption is small. Since a substantial proportion of fish preservation is done on floating canneries, their chemical needs cannot be included with the demand from the state itself.

Alaska's relatively small population—a little over 200,000—accounts for small consumption of household chemicals. Nevertheless, a chemical plant in Anchorage makes liquid bleaches, liquid floor waxes and a liquid starch for local use.

Industrial gases are produced in small but modern plants in Anchorage and Fairbanks.

► **Bustling Water Traffic**—Transportation of bulk products by water to and from Alaska is well established, although largely northbound with limited backhaul except from southeastern portions.

Large petroleum companies carry out tanker operations. The Alaska Steamship Co. provides

# Progress Report...

## Three new functional fluids

Three new aliphatic diethers of polypropylene glycol are now being produced in commercial quantities by CARBIDE. These synthetic functional fluids are available in three viscosity grades, Ucon lubricant DLB-62-E, Ucon lubricant DLB-140-E and Ucon lubricant DLB-200-E. All are miscible in hydrocarbon oils, and should be of particular interest to manufacturers of specialty lubricants, hydraulic fluids, greases, and gear oils. Other applications are indicated as heat transfer media fluids for use at extremely high pressures, and as inert solvents for processing operations.

Viscosity indexes of the new DLB series of Ucon lubricants range from 160 to 190. They contain no wax or pour point depressants and have stable ASTM pour points from -50 to -85°F. In common with all Ucon lubricants, the DLB series fluids have outstanding load-carrying capacity and anti-wear properties. The new lubricants form soluble fluids or volatile products, not sludge or varnish, and free carbon or coke is not formed in most high temperature uses. Thus, clean burnoff is assured in the presence of air with no gummy residues.

DLB series Ucon lubricants are shear stable, do not hydrolyze in the presence of acid, neutral, or base solutions, and do not become rancid during storage. Properly inhibited, they show good oxidation resistance up to 500°F. Under ordinary conditions, the DLB fluids are non-corrosive to common metals, and have little or no effect on most rubber compounds.

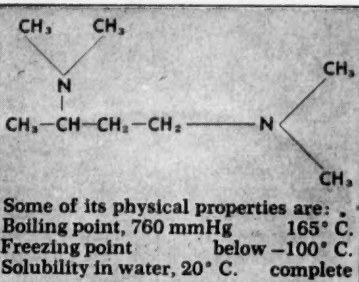
When suitably inhibited, these lubricants make high quality automatic transmission fluids. They may be blended with petroleum oils to improve low temperature performance and high temperature stability. The DLB series fluids have been utilized to formulate greases with improved viscosity-temperature characteristics. Because of their high load carrying capacity they can be used as the base for wide temperature range gear oils. They can also be employed as excellent hydraulic fluids in the range of -20 to 400°F.

CARBIDE's Ucon lubricants, DLB series, are available now in tank car quantities, drums (carload or LCL lots), or in economical compartment tank car or truck shipments with other

CARBIDE products. A Technical representative in the CARBIDE office nearest you will be glad to furnish more details about these useful fluids. For a technical information bulletin, check the coupon on this page.

## New chemical for you to explore

Its name is long, so we'll mention it only once: N,N,N',N'-tetramethyl-1,3-butanediamine.



This di-tertiary amine is a colorless, stable liquid, soluble in common organic solvents. It has proved to be a highly active amine catalyst for polyurethane foams, with fast curing rate, and low odor level, producing soft foams.

The new compound should be evaluated as a catalyst for epoxy resins. Its unique structure suggests applications in high energy fuels.

You can get this new chemical from CARBIDE in 55-gallon drums in LCL or carload lots. Technical Information Bulletin F-40392 contains data on physical and physiological properties. For a copy, please check the coupon.

## Booklet gives tips on handling ethylene oxide

Processors who use or are considering the use of ethylene oxide will want a copy of CARBIDE's 20-page booklet on operating procedures for this workhorse of the chemical industry.

Ethylene oxide is the starting point for many glycol-ethers, esters, amines, and other derivatives. One of these derivatives, acrylonitrile, is an intermediate for certain elastomers, plastics, and synthetic fibers.

Fatty acids reacted with ethylene oxide produce polyoxyalkylene esters valuable as nonionic emulsifying

agents and detergents. The ethylene oxide adducts of alkylated phenols are important nonionic detergents and surface-active agents. Other applications for ethylene oxide are as fumigants, and sterilizing agents.

If you are working with this ever-useful chemical, make certain you get a copy of "Operating Procedures for Ethylene Oxide." In the booklet you will find recommendations for sampling, handling, unloading, and storing, plus ordering and shipping information. Please check the coupon.

**Tear out this coupon.** Check the boxes on which you'd like more information, and mail to Dept. HE, Union Carbide Chemicals Company, 30 East 42nd Street, New York 17, N. Y.

- ☐ Ucon Lubricants Bulletin  
☐ Bulletin F-40392  
☐ "Operating Procedures for Ethylene Oxide"  
☐ 1959 Physical Properties of Synthetic Organic Chemicals—a comprehensive description of the properties and applications of more than 400 CARBIDE chemicals.

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regularly scheduled freight service from Seattle to most Alaskan coastal points. At least seven large tug-barge companies operate from California, Oregon and Washington points to almost anywhere on the coast of Alaska.

Because of the low level of backhaul service, providing revenues for return trips from Alaska, water shipment rates are presently quite high. Some estimates for future bulk shipments by barges of substantial size (7,500 tons) are on the order of \$20/ton from Pacific Northwest ports to Alaskan ports, and as little as \$7/ton for return hauls.

► **Plenty of Ports**—Nearly all points in the Panhandle are within reach of deep-draft harbors. The Prince William Sound area has all-year ports at Cordova, Valdez, Seward and Whittier.

Valdez is served by an all-year highway interconnecting Fairbanks, Anchorage and the Alaska Highway. Whittier is the terminus of the Alaska Railroad, with no highway facilities. Seward is served by both highway and railroad facilities.

Port facilities are also at Cordova and Seldovia, on Kachemak Bay in the Kenai Peninsula, and also at Kodiak. Aleutian points, and those on the Bering and Arctic coasts, have a variety of port facilities. But most of these are open only during the summer months.

The table on p. 90 shows how waterborne chemical shipments grew between 1952 and 1957. (These figures account for nearly all chemicals shipped to Alaska, save for air and truck transport of certain pharmaceutical products.)

Of the 1957 totals, about 60% reflected shipment of sulfur and industrial chemicals to the Ketchikan Pulp and Paper operation at Ketchikan.

Most of these chemicals originated in U. S. West Coast ports. Major exception was sulfur, which in 1957 was designated a foreign import to the Ketchikan area.

► **Via Air and Overland**—Modern air transportation—comprising ten certificated airlines—places Alaska's main communities within reach of most cities

"outside." Anchorage is the hub of transpolar air routes.

In addition, there are literally dozens of charter operations serving all areas with modern aircraft, including helicopters. Air freight moves enormous quantities of goods on frequent schedules both intra- and inter-Alaska.

Some overland transport is available during winter months in Arctic areas, employing specialized motorized hauling equipment which travels on the frozen muskeg and tundra.

Considerable all-year truck movement exists along the Alaska Highway between Alaska and the rest of the U. S. Within the new state, there are over 5,100 mi. of roads, of which 2,000 is paved. About 3,000 mi. of this internal system is open to traffic throughout the year.

No rail connections exist as yet between Alaska and the rest of the nation. The U. S. Alaska International Rail and Highway Commission is sponsoring a re-investigation of a possible rail system to link Alaska with the West Coast. The Alaska terminus would most likely be Fairbanks, the northern end of the Alaska Railroad which extends southward to the Matanuska Valley, to Anchorage, and thence to the Kenai Peninsula ports of Seward and Whittier. (The latter port is restricted pretty much to military traffic.)

► **Fuel Picture**—Fuel costs in Alaska vary with location. Highest of those outside Arctic points are in the Fairbanks area.

In the Panhandle, or Southeast, fuel oil prices are close to those in Puget Sound areas. P. S. 300 oil in bulk quantities ranges from 10-11¢/gal. in the Kenai Peninsula area (including Anchorage) to almost twice that in the Fairbanks area.

Local coal delivered in industrial quantities in the Anchorage area runs around \$14/ton, with a Btu. content of slightly under 12,000. Coal from the Healy Creek fields delivered to Fairbanks will run \$10-11/ton, with an as-received Btu. content of about 8,800.

Electric power rates in Alaska are high in comparison with the Pacific Northwest, due for the most part to the small scale of

present generating plants. Wholesale power costs much under 1¢/kwh. are not likely in the immediate future.

Large industrial operations, like those of the pulp and paper producers, rely on byproduct steam and the output of local hydroelectric plants built to serve them.

► **Hydro Power Potential**—But Alaska's hydroelectric power potential is very great and virtually untapped. When such projects as the Bradley Lake installation on the Kenai Peninsula and the Susitna River unit are constructed, wholesale power costs may be in the range of 3-4 mills/kwh. for high load-factor utilization.

Larger projects, such as Taiya, Wood Canyon and Rampart, should provide very low power costs—comparable to those of the Pacific Northwest—in the next ten years or so.

Although water is ubiquitous in Alaska, it cannot be considered always satisfactory for industrial use. Surface water, frequently glacier-fed and subject to winter freezeups, contains a substantial amount of glacial silt. High mountain lakes are of unusual purity and ground waters, where available, are usually of reasonable quality.

► **Labor, Living Costs**—Seasonality of construction employment in Alaska, together with a history of cost-plus defense contract work, has resulted in high wage rates in most instances. Year-around contracts call for somewhat lower rates.

By and large, all of Alaska is highly unionized. Hourly rates for construction workers range from \$3.80, for general building labor, to \$5.25 for electricians.

Cost of living, on the other hand, is also higher in Alaska than in the rest of the U. S. Consumer prices average 30% higher in Juneau than in Seattle, Wash., 40% higher in Anchorage, and 56% higher in Fairbanks.

Generally speaking, nearly all areas of Alaska are suitable for industrial plant establishment. Climatic conditions, except in the extreme western and Arctic areas, can be compared with those of the northern Great Lakes and Plains states.



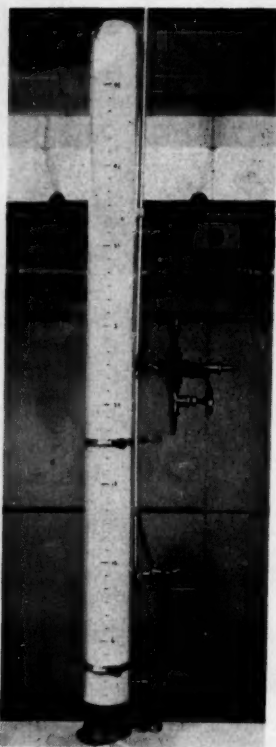
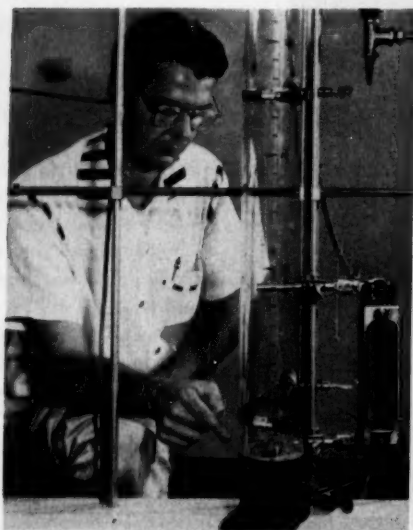
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in flexible  
process control...***

the Beckman 123 Data Processing System. ☒ Use it alone for process data logging and alarming. Use it with a general-purpose computer for computer control. Its flexibility allows you to first study and then control your process...as well as modify process variables and easily reset controls. ☒ In addition to this flexibility, the 123 Data Processing System offers all-transistorized circuits for maximum dependability... pinboard programming for ease of operation...100 or more channels to handle any logging problem...typewriter, paper tape, or punchcard readout... visual and audio alarms. ☒ Let a Beckman stream-control specialist help you to a 1-2-3-4 building block solution to your process control needs... from sample handling (1) and stream analysis (2) through data processing (3) and digital computing (4) to an ultimate closed loop. For more information on the 123 Data Processing System or an on-stream survey, write for Data File 14-37-09.

**Beckman** /  
Scientific and Process Instruments Division  
Beckman Instruments, Inc.  
8100 Fullerton Road,  
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See this and other Beckman Products,  
Booth 446, Chicago ISA Show, Sept. 21-25.

New foam generator permits cleaning large volume, complex equipment with a little liquid.



Little liquid . . . . . gobs of foam

## More Cleaning/Oz. With Foam

More thorough, less costly cleaning of heat exchangers, process equipment and pipelines are the dividends claimed for a new foam method of cleaning.

Dowell has developed a foam generator which makes it possible to clean large-volume systems with a relatively small amount of liquid because ratio of foam to solvent will average 20 to 1. In the generator, a wetting agent and a cleaning liquid such as inhibited hydrochloric acid solution are foamed by controlled compressed air.

Density of the foam is regulated for optimum performance.

The foam solvent is pumped directly from the generator into the tank, pipe or tower to be cleaned. When the vessel or tank is filled with the chemical foam, the process continues with the foam passing into a foam breaker and a filter which removes material dislodged by movement of the foam through the equipment. Solvent is then recycled through the foam generator and the unit being cleaned. Routine tests tell when the job's done.

It will now be possible to chemically clean towers, pipe assemblies and other equipment that would not stand the weight and hydrostatic pressure caused if liquids were used.

Concentrated chemical solvents can be used where needed. In many cases, the cost of concentrated liquid solvent was prohibitive due to large volumes required.

Complex equipment can be cleaned because foam solvent completely fills every loop and bend, every nook and cranny.

It is possible to eliminate after-rusting problems because the cleaned metal surfaces are not exposed to air during the cleaning process. Foam solvent is displaced directly with a foam rinse or flush followed by a foam passivator. — Dowell Div., Dow Chemical Co., Tulsa, Okla. 94A

## Radioactivity in a Cage

Molecular cage for radioactive gas yields safer source of beta rays.

A new method for crystallizing hydroquinone in the presence of gaseous krypton-85 creates a source of radioactivity which can be used with a far greater margin of safety than heretofore possible.

As the crystals form, atoms of krypton become trapped within the interlocking network of molecules. The resulting material is called a clathrate. If released, the krypton it contains would expand to approximately thirty times the original volume of the clathrate. The crystal structure does not interfere with the radiation emitted by the radioactive krypton but it does contain the krypton atoms just as effectively as thick walled pressure cylinders.

Developers believe that the



## **SUPERIOR SOLVENT FOR ROTOGRAVURE INK**

The high solvency of Laktane fulfills a crucial requirement for rotogravure ink—proper viscosity reduction. In fact, it provides greater solvency for ink vehicles than any other aliphatic diluent. Laktane is also perfect for fast drying lacquers because it offers the highest aromatic and naphthene content of any commercial aliphatic diluent. And Laktane has a remarkably clean odor . . . and is less expensive than many other solvents used in lacquer formulations!

For further information or technical assistance, write: Esso Standard Oil Company, Solvents Div., 15 West 51st St., N. Y. 19, N. Y.



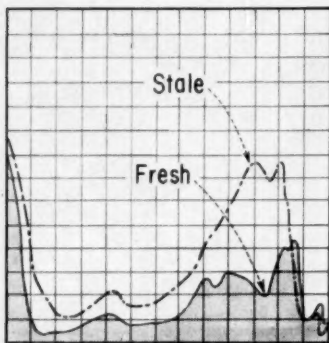
**PETROLEUM SOLVENTS**

**In Industry after Industry... "ESSO RESEARCH works wonders with oil"**

greater margin of safety afforded by the new process will allow use of large sources of radioactive materials for many new applications in the paper, metal, rubber and chemical industries.

In its gaseous state krypton-85 has all but one of the properties desired in a radioisotope. It is nearly pure beta emitter. Beta particles have reasonable strength. Its half life is moderately long (10.3 yr.). Most important, krypton is an inert gas and cannot be stored or metabolized by the human body.

Only its gaseous state has prevented widespread use. Sealed containers for the gas are expensive to make. Large quantities cannot be compressed to make a small source of high activity because this would require use of a thick walled container which would absorb most beta particles emitted.—Tracerlab, Waltham, Mass. 94B



### Coffee's Fingerprints

Chromatographs jibe with patterns of ingredients in fresh and stale coffee.

Using chemical "profiles" obtained with gas chromatography, I. S. Fagerson of the University of Massachusetts has conducted experiments to determine the particular compounds and/or the pattern of ingredients which characterize those foods preferred for taste, aroma, etc. by consumer panels. Establishment of a correlation between the taste panels' selections and a unique characteristic in the sample's flavor

fingerprint leads to positive control over flavor and aroma in the production of food.

Identification of the compounds that make up the flavor-aroma of coffee and tracing of the manner in which aroma develops during roasting have been substantially advanced through gas chromatography.

Blending of instant coffee is one of the several areas of the food industry in which the use of gas chromatography has progressed to a point where it is possible to use the technique as a direct control of the process line.—Perkin-Elmer Corp., Norwalk, Conn. 96A

### Yttrium Oxide

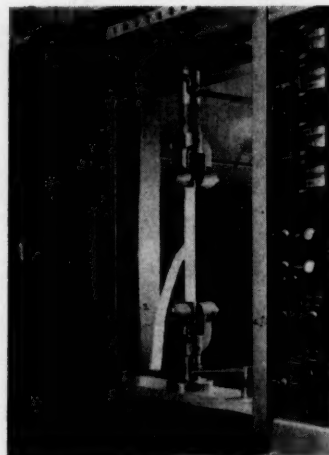
Electronic grade for making yttrium-iron garnets.

A new electronic-grade yttrium oxide has a minimum purity of 99.9% with respect to total impurities present and its uniqueness is characterized by its extremely small particle size (nominally 2-5 microns) and its high reactivity. It is designed to meet the requirements of the electronic industries in the production of yttrium-iron garnets for microwave transmission.

The small particle size, combined with the high reactivity, results in a more complete solid

state reaction between yttrium oxide and iron oxide that occurs during the production of yttrium-iron garnet.

This electronic-grade yttrium oxide is available in commercial as well as developmental quantities.—Michigan Chemical Corp., St. Louis, Mich. 96B



### Textile Sizing

Saturated with it, cloth shows 50% more film strength on Instron test.

A new latex for rug backing which requires no vulcanization and eliminates the accelerator system has been announced.

### —Newsworthy Chemicals—

Page Number is also  
Reader Service Code Number

Foamed cleaner permits large volume cleaning.....	94A
Safer beta-ray source via molecular cage for gas.....	94B
Coffee flavor traced to specific ingredients.....	96A
Yttrium oxide available in electronic grade.....	96B
Textile sizing shows 50% more film strength.....	96C
Methacrylate and silicone tires for high temperature use	98A
Low turbidity ingredients for detergents.....	98B
Vinyl acrylic resin latex gives polishes high gloss.....	98C
Polio vaccine joins three others for combined doses.....	98D
Material for bearings adds wear resistance to Teflon assets	98E

—For more details, use Reader Service Card—

# LINDE packaged oxygen plant sets nine-year record for availability!

THE LINDE oxygen plant shown here has been serving a leading chemicals producer "over-the-fence" continuously since 1949. Its operating log shows a 98%+ availability factor. Next year, capacity will go up from 360 to 800 tons of oxygen a day.

You can expect the same continuity of supply with a LINDE packaged plant serving your process. Your LINDE plant will be the product of fifty years' experience in the design, manufacture, and operation of air separation plants and low temperature equipment. LINDE is uniquely qualified to provide air separation plants for the supply of oxygen and/or nitrogen as well as the associated low temperature equipment for:

- liquefying hydrogen, helium and fluorine
- purifying hydrogen and helium
- separating hydrogen from coke oven gas
- ammonia and methanol synthesis
- upgrading of natural gas
- other extremely low temperature processes.

Put LINDE's more than 50 years' experience in gas separation techniques to work for you. Write Dept. CE-92 LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y. In Canada: Linde Company, Division of Union Carbide Canada Limited.

"Linde" and "Union Carbide" are trade-marks of Union Carbide Corporation.

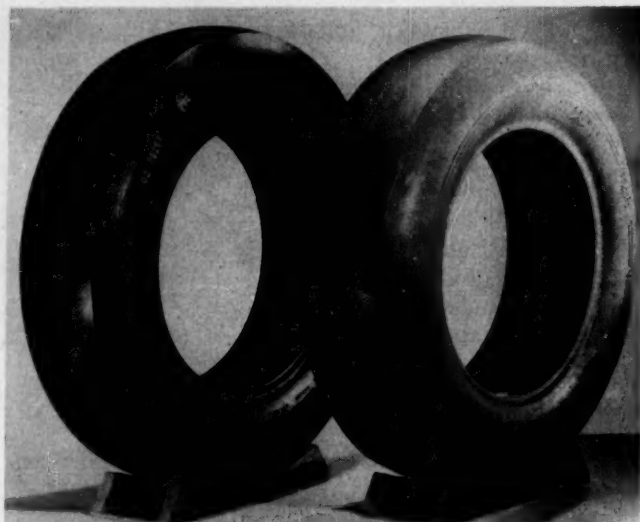


*Linde*

TRADE-MARK

Industries that regularly require large quantities of oxygen or other atmospheric gases can obtain these they need from a LINDE plant on their own site. The oxygen plant illustrated—built, owned, and operated by LINDE—is at a plant of one of the nation's largest chemical processors.

UNION  
CARBIDE



### Rubbers Are Methacrylate and Silicone, Cord's Steel

To screen available commercial elastomers and to prepare new ones for high-temperature use are objects of a program conducted by Firestone Tire & Rubber Co. for Wright Air Development Center.

The photograph shows two prototype tires: One from Firestone methacrylate rubber and one from Dow Corning silicone rubber. None of the tires produced to date have been satisfactory for dynamic testing, let alone actual use. They do illustrate progress in working out handling and fabrication problems. These problems are com-

plicated by the fact that existing organic tire cords lose most of their strength at 400 F. and higher, which led to a decision to use steel wire.

So far, in the 400-600 F. range, only copolymers of vinylidene fluoride with perfluoroprene and certain high-strength silicone rubbers have given vulcanizates which retain substantial physical properties. At temperatures around 400 F., resin-cured butyl compounds and metal oxide-cured copolymers of butadiene and methyl methacrylate retain properties. — Firestone Tire & Rubber Co., Akron. 98A

Elimination of the accelerator system corrects certain problems which are often caused by sulfur and sulfur-containing compounds.

Known as Dylex K-42, the latex contains 60% styrene and 40% butadiene, has considerably less emulsifier than the conventional styrene-butadiene latex, and is fortified during polymerization. As a result, film strength is much higher

than that of conventional latex and is as much as 50% higher when used on certain synthetic fibers.

Because persistent odors in certain carpets coated with conventional backsizings have been traced to sulfur compounds in the accelerator system, the elimination of these products in the new latex eliminates odor problems. Range of permissible dye-stuffs has been enlarged since

copper poisoning has been traced to a reaction between ingredients of the accelerator system and certain types of dye-stuffs. — Koppers Co., Pittsburgh, Pa. 96C

### BRIEFS

**Tetrapotassium pyrophosphate** with a new low-turbidity makes it possible for manufacturers of general purpose liquid detergents to formulate clear, cloudless products. It assures a minimum of potassium tripolyphosphate and other trace impurities which cause unsightly cloudiness in finished products. — Monsanto Chemical, St. Louis. 98B

**Vinyl acrylic resin latex** called Resyn 2700 is said to produce high gloss, self-polishing floor polish formulations that are both nonyellowing and scuff resistant. — National Starch & Chemical Corp., N. Y. 98C

**Four-in-one vaccine** protects children against polio, diphtheria, whooping cough and tetanus. Called Quadrigen, it reduces from six to four the number of injections required to immunize against the four diseases. — Parke-Davis Co., Detroit. 98D

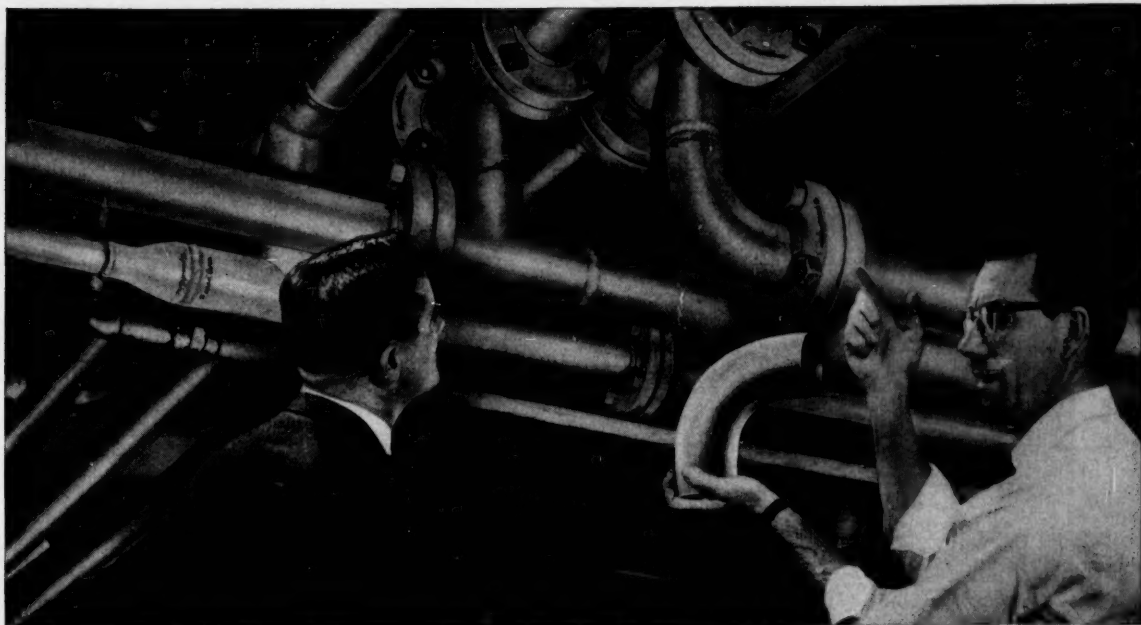
**Material for bearings** combines the lubricity of Teflon with greatly improved resistance to wear and cold flow. It is a homogeneous combination of ceramic or glass-microfibers, Teflon, and molybdenum disulfide. — Rogers Corp., Rogers, Conn. 98E

### For More Information . . .

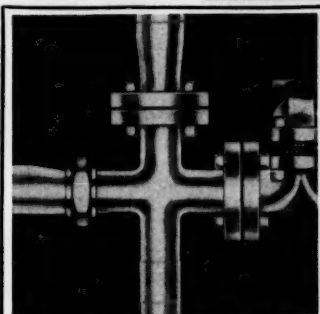
about any item in this department, circle its code number on the

### Reader Service

postcard (p 235)



## **SPEEDLINE'S EXTRA LENGTH FEATURE GAVE US MORE PIPE PER FITTING DOLLAR**



Flange where you want to, weld where you want to . . . any type joint can be used with any Speedline fitting. The longer straight section provides ample clearance that simplifies installation and permits easier hook-up of valves, flanges, etc. even in confined areas. The extra length feature is common to all Speedline Ells, Tees, Crosses, Reducers and Bends.

SEE DISTRIBUTOR LISTING PAGE 593 IN  
CHEMICAL ENGINEERING CATALOG.

Extra length on *every* end of *every* Speedline corrosion resistant fitting adds up to *real* savings in pipe costs, compared to systems using conventional fittings (see table).

Time and labor costs are also reduced from preliminary design to finished installation. Design detailing is minimized because any type joint can be used on any—or *all*—ends of a Speedline fitting. Speedline's longer length gives more clearance for welding and faster, *easier* pipe aligning . . . permits flanging *without* welding by a simple rolling-in operation! And because Speedline fittings are specially designed for use with low cost, light wall stainless pipe, material costs are substantially lower from the start.

Specify Speedline for your process lines—first in the industry to offer *extra* length for *greater* economy. Write for *free* catalog.

### **SPEEDLINE'S EXTRA PIPE LENGTH BONUS**

I.P.S. SIZE	1/2"	3/4"	1"	1 1/4"	1 1/2"	2"	2 1/2"	3"	4"
90° Elbow	2 1/2"	3"	2 3/4"	2 1/2"	2 1/2"	3"	2 1/2"	4"	4 1/2"
45° Elbow	2 1/2"	3"	2 3/4"	2 1/2"	2 1/2"	3"	2 1/2"	4"	4 1/2"
Tee	4 1/8"	4 1/2"	4 1/8"	3 3/4"	3 3/4"	4 1/2"	4 1/8"	4 7/8"	4 7/8"
Cross	5 1/2"	6"	5 1/2"	5"	4 1/2"	6"	6 1/2"	6 1/2"	6 1/2"

With 100-2" Speedline elbows you get 25' more pipe than with conventional fittings. How do these pipe savings add up for your requirements?

*Speedline*

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### **CORROSION-RESISTANT FITTINGS**

**STAINLESS STEEL**

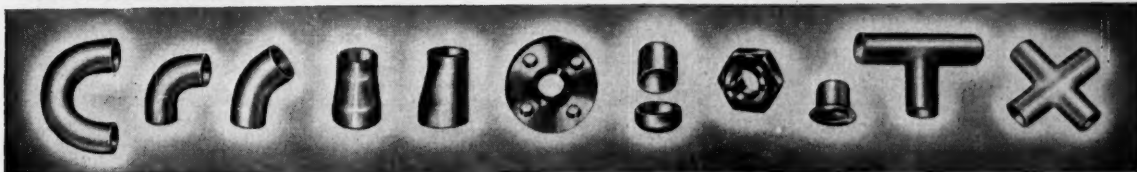
SCHEDULES 5 AND 10

**ALUMINUM**

SCHEDULES 10 AND 40

HASTELLOY, TITANIUM AND OTHER ALLOYS ON APPLICATION

901-R1

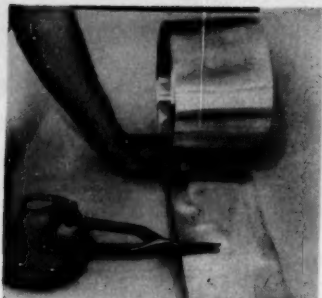


Manufactured by HORACE T. POTTS COMPANY • 500 E. Erie Ave., Philadelphia 34, Pa.

DEVELOPMENTS . . .

## PROCESS EQUIPMENT

EDITED BY C. C. VAN SOYE



Snip . . .  
... inflate . . .



. . . use

## New Metal Tubing: Inflate It on Site

**Today:** You receive a trailer-truck load of seamless, thin-wall tubing.

**Soon:** Similar load arrives in small box.  
You inflate it when needed.

These days, a lot of people are talking about ill effects of inflation on the national economy. But at Calumet & Hecla, Inc., the big inflation discussion

centers around "Strubing," the company's new lightwall seamless tubing that can be shipped in ribbon form and inflated at the point of use.

Strubing (strip tubing) offers two main advantages, say company officials. First, point-of-use inflatability drastically cuts shipping costs—only the

# UNION 20-S

**The Super Stainless For Resisting  
Hot Sulfuric Acid**

**Announcing a  
New Source for:**

pipe

tube

strip

sheet

plate

bar

wire

in stock for immediate delivery.

Described in Bulletin 20-S.



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**UNION  
STEEL CORPORATION**

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STAINLESS and SPECIALTY STEELS - exclusively

tube "walls" are shipped, not the "holes."

And second, the process for making Strubing, technically classified as cold rolling, yields thin-wall tubing of materials and thicknesses either unavailable today or available only at prohibitive cost.

► **Inflation Technique**—Methods and equipment used for inflating Strubing vary with application and dimensions of the product. The company's engineers have successfully tested hydraulic pressure, air pressure and mechanical means.

Obviously, the thinner the walls, the lower the required inflation pressure. In some sizes, Strubing will inflate under influence of ordinary tap-water pressure.

► **Wide Size Range**—Experimental production starts this fall on sizes ranging from "smaller than the lead in a pencil" to "large enough for a man to walk through."

Wall thickness can vary from the equivalent of household metal foil to that of conventional pipe. And it will be possible to ship coil lengths of as much as 15,000 ft.

► **Potential Applications**—Here's a partial listing of Calumet & Hecla's predicted product applications in the process industries.

- "Lining - by - inflation" techniques might lead to low-cost, corrosion-resistant vessels and piping.

- Leaky pipe? Insert a length of Strubing, then inflate.

- Because of the product's availability in long lengths, it might fill the bill for electrical conduit or instrumentation tubing.

- Truck-mounted Strubing reels could be a quick, economical way to lay networks of temporary field pipelines for water, fuel or compressed air.

- Strubing in metal-foil thickness holds promise as a packaging material in the food industry.

► **How They Make It**—During manufacture, the first step is to make a length of seamless tubing by conventional techniques. This tube is then passed through a rolling mill to form the flattened ribbon.

Successive passes through the rolls thin the walls and elongate the ribbon, without changing inside tube diameter. For example, an 800-ft. reel of standard  $\frac{1}{8}$ -in. copper tubing can give, on rolling, a 3,000-ft. reel of Strubing which, when inflated, makes  $\frac{1}{8}$ -in. tubing with a wall thickness of  $\frac{1}{16}$  in.

Inherent in the inflated product is a pair of external longitudinal fins or ribs. These add stiffness to the thin walls. If desirable, the fins can be removed.—Calumet & Hecla, Inc., Wolverine Tube Div., Allen Park, Mich. 100A



### Tube Packs

Bundles of color-coded tubes can carry air.

Extruded polyethylene tube packs containing from 2 to 37 color-coded, small-diameter tubes are available for air-carrying service with instrumentation systems. The jacket, an extrusion of abrasion-resistant Geon vinyl compound, protects the interior tubes from external damage and aids in installation of the system. Geon is a product of the B. F. Goodrich Co.—Pyramid Plastics, Chicago, Ill. 102A

### For More Information . . .

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### Reader Service

postcard (p. 235)



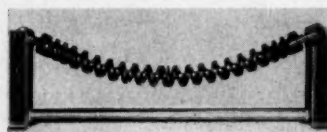
### Marking Tape

Identifies fluid content of process piping.

Pressure-sensitive tape and labels in colors to meet ASA Pipe Coding Standards A-13 fulfill maintenance standards requiring legend marking plus color banding of pipelines. The self-sticking material withstands temperatures to 300 F.

Manufacturer recommends application of the banding tape in conjunction with pipe markers. This combination identifies content on the underside of the pipe with both color and legend, and completely around the pipe with a color that identifies type of contents.

Both tape and markers are guaranteed to stay on piping for a minimum of 5 yr. Tape roll is 2½ in. x 30 yd.—W. H. Brady Co., Milwaukee, Wis. 102B



### Conveyor Idler

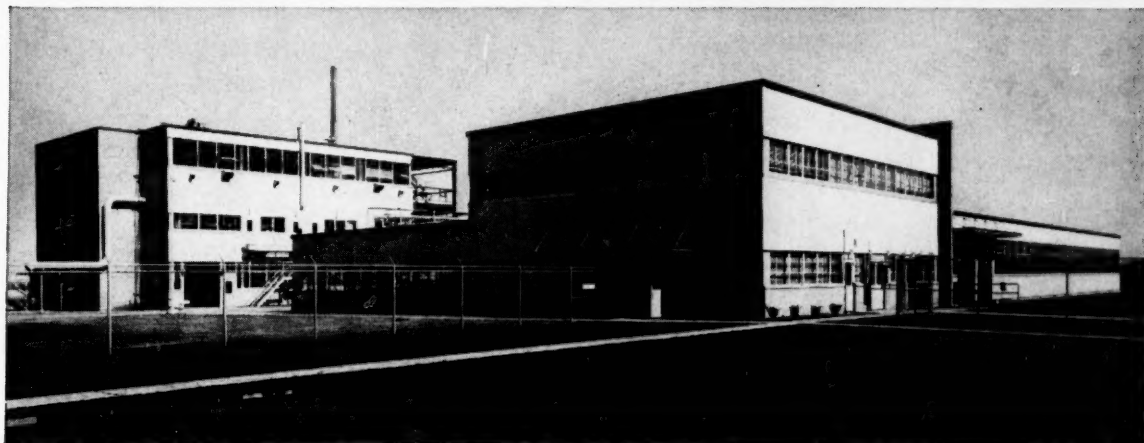
Spiral construction stops buildup of sticky powders.

With the new spiral conveyor idler shown above, self-cleaning action resulting from constant end-to-end flexing stops buildup of sticky materials. The idler conforms to variations in belt load, providing more uniform conveyor action. Also, torsional strength, resulting from the continuous spiral design, insures long life.

Each idler consists of a 3-in. diameter double corkscrew of  
(Continued on p. 106)



*Blaw-Knox builds complete Henry, Illinois, plant including all auxiliary facilities for B. F. Goodrich Chemical Company. Extensive tank farm includes raw material, finished product, and fuel storage. Main units shown below include process building (at left) office and warehouse units (at right).*



## **B. F. Goodrich Chemical builds new \$5 million organic chemical plant**

This new plant, built by Blaw-Knox, enables B. F. Goodrich Chemical to supply the oil, rubber, and plastics industries with a new series of antioxidants and other specialty chemicals.

In addition to the process areas on this complete-from-grass-roots project, Blaw-Knox's contribution included design, construction, and installation of the plant's auxiliary facilities. Utilities—including the water supply, waste disposal, and fire protection systems—were designed to handle about four times the plant's initial capacity. The tank farm with its extensive and complex piping system also was built to accommodate future increased output.

Throughout the entire project Blaw-Knox teamed closely with B. F. Goodrich to design a plant with a built-in future in meeting the increasing demand for rubber chemicals.

Contact Blaw-Knox Chemical Plants Division for a preliminary discussion on your next project. Headquarters in Pittsburgh; branch offices in New York; Haddon Heights, N. J.; Washington, D. C.; Birmingham; Chicago; and San Francisco.



*plant builders for industry...*



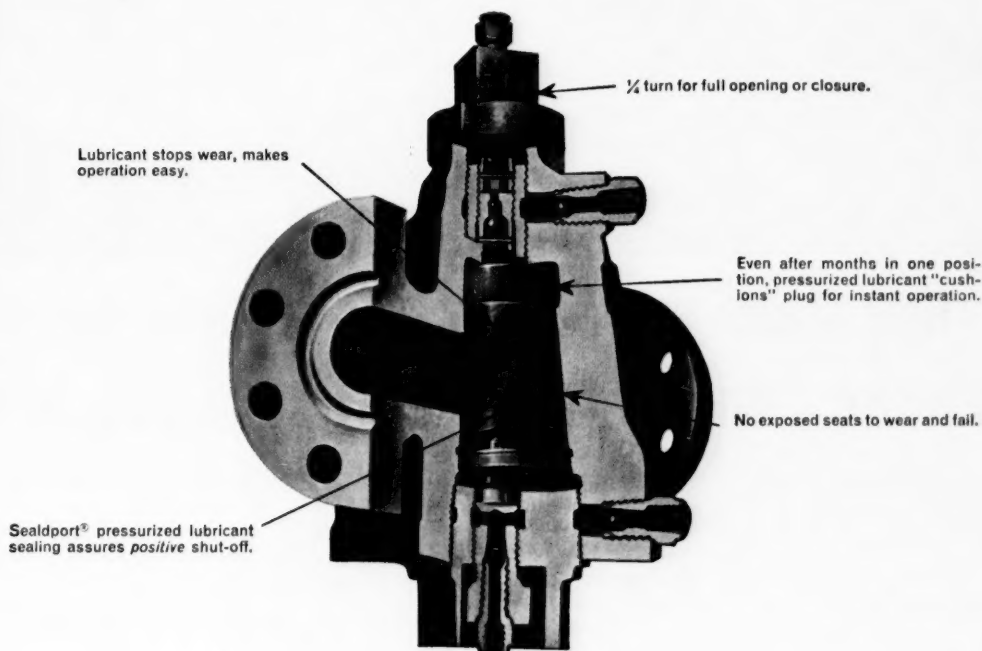
**ROCKWELL-Nordstrom VALVES**

# Confidence

A parachute is worn with the hope that it will not be used, yet with the *confidence* that it will do the job if it's needed.

Some valves are like parachutes. On fire lines or emergency shut-offs, for example, they're the valves you never want to use. But they are the ones that must perform *perfectly* if the need arises. Most often you'll see Rockwell-Nordstrom lubricated plug valves in these "confidence" services because half a century of on-the-job proof has established one important fact: *they are valves you can depend on*. And it's this confidence on the tough services that has made them demanded so often on *every* service.

## INSTANT, DEPENDABLE VALVE OPERATION



Rockwell-Nordstrom is the original and world's most complete line of lubricated plug valves with sizes from 1/4" to 36" and pressures to 15,000 lb. Available at leading oil field and industrial supply houses everywhere. For details, see your supplier or write: Rockwell Manufacturing Company, Pittsburgh 8, Pa. If you live outside the U. S. A., write: Rockwell International Division, Pittsburgh 8, Pa.

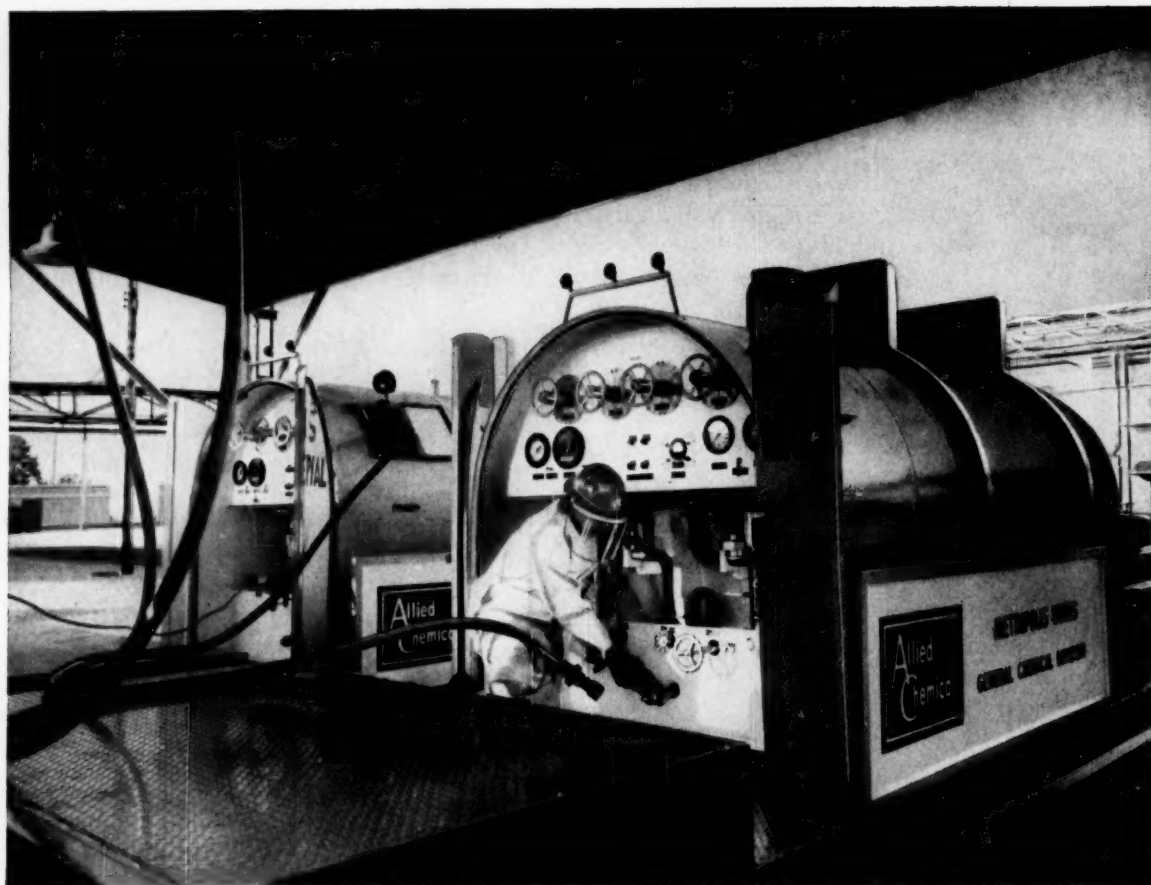
©Reg. T.M. Rockwell Manufacturing Company

ROCKWELL-Nordstrom VALVES

another fine product by

**ROCKWELL**





## New trailer delivers 2½ tons of liquid fluorine Corrosive chemical travels safely, stays pure, in Monel

Commercially pure liquid fluorine in bulk is now being shipped thousands of miles. It goes in 2½-ton capacity truck-trailers like those shown above.

The trailers are equipped to cool the fluorine below its boiling point with liquid nitrogen. Units are said to be so efficient that fluorine will remain liquid several weeks even in searing desert weather. Bulk fluorine shipment and the equipment to accomplish it are developments of General Chemical Division, Allied Chemical Corporation.

### **Inertness of Monel to fluorine safeguards shipments and quality**

The inner "business" tank in the trailer is Monel\* nickel-copper alloy. The enclosing nitrogen tank is Nickel-containing stainless steel.

Both Monel alloy and the Nickel-containing stainless steel retain excellent ductility and strength well below the sub-zero temperatures of liquid nitrogen.

They're well able to withstand unexpected pressures and the shocks of travel.

In tanks made of these alloys the fluorine proceeds tranquilly to its destination. There it can be stored in the same tanks until used.

Monel alloy is also highly resistant to corrosion and to ignition in fluorine at high temperatures since it forms a protective adherent fluoride film. Shipment remains free of contaminating corrosion products.

Protect *your* fluorine processing and handling equipment with Inco Alloy Products. A new fluorine booklet, "Handling Fluorine and Fluorine Compounds," goes into detail on fluorine corrosion, suggests means of overcoming it. If you like, we'll send you a copy.

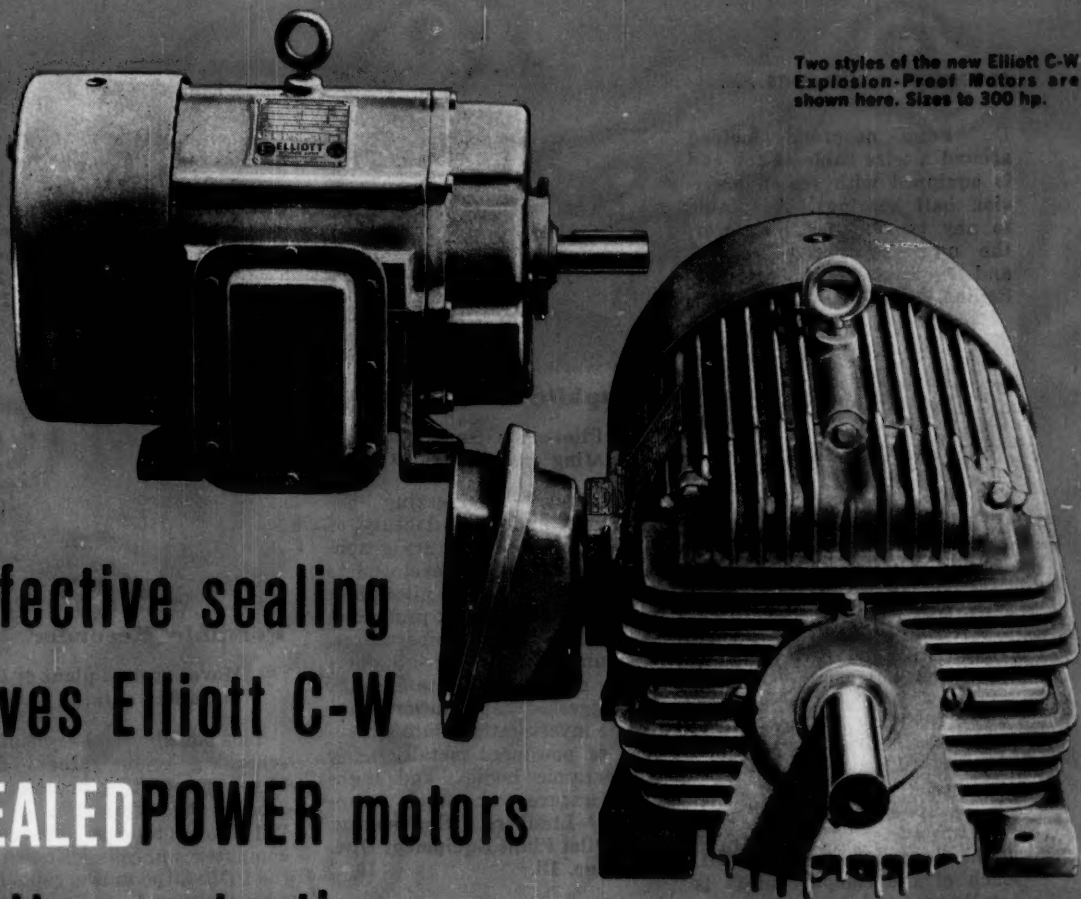
\*Inco trademark

### **HUNTINGTON ALLOY PRODUCTS DIVISION**

The International Nickel Company, Inc.  
67 Wall Street New York 5, N. Y.

# **MONEL®**

Two styles of the new Elliott C-W Explosion-Proof Motors are shown here. Sizes to 300 hp.

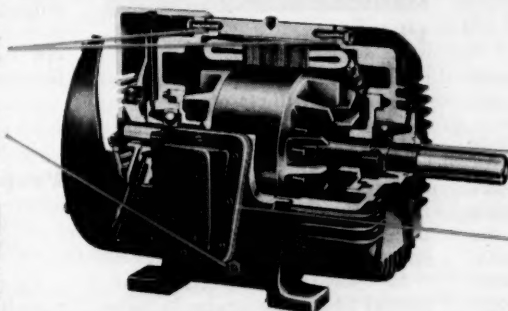


effective sealing  
gives Elliott C-W  
**SEALEDPOWER** motors  
better protection  
against moisture, dust, fumes, corrosion

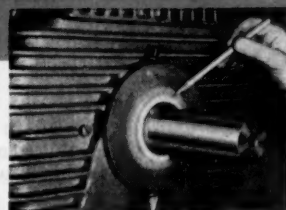
**LONG, SNUG BRACKET SEAL.** Close-fitting, deep rabbet provides explosion-proof type seal for all SEALEDPOWER motors.

**EASILY ACCESSIBLE,** automatic breather and drain plug, underwriters approved, for removing internal moisture accumulations.

**NEW DATA** on the complete line of Elliott C-W SEALEDPOWER motors is given in Elliott Bulletin PB 6000-2. Send for free copy today.

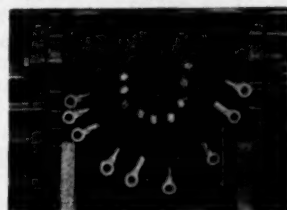


Elliott explosion-proof motor—underwriters approved.



**ROTATING SLINGER PREVENTS** entrance of dirt and moisture through the bearing and shaft opening.

**NO LEAKAGE HERE.** Tightly sealed leads and opening. Metal-to-metal fit between conduit box, frame and cover.



**ELLIOTT Company**

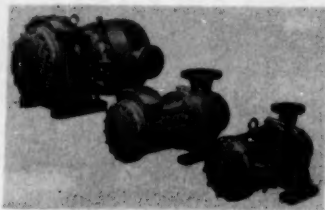
Crocker-Wheeler Plant

Jeannette, Pa.



## EQUIPMENT DEVELOPMENTS . . .

Du Pont neoprene molded around a wire cable. Each end is equipped with sealed precision ball bearings. Adaptable to any type of belt conveyor, the unit is light in weight and easily replaced.—Hewitt-Robins, Stamford, Conn. 102C



### Pumps

**High-temperature units cut operating costs.**

Designed to handle heat-transfer liquids for process heating (diphenyl, Santowax, Dowtherm, etc.), Type HT single- and two-stage pumps cover capacities from 50 to 900 gpm. at heads from 100 to 500 ft. Each of the compact units is totally enclosed; no stuffing box.

At temperatures up to 500 F., no cooling is required; from 500 to 930 F., water cooling is advisable. Motors are explosion-proof. Patents are pending; the Swiss manufacturer is looking for a U. S. licensee.—Hany & Cie, Meilen, Switzerland. 106A

### Water Filter

**Easy-cleaning item made of plastic materials.**

A new, all-plastic diatomite filter for efficient cleanup of potable or process water offers advantages of low operating cost, easy cleaning, plus the elimination of rust, special liners and paint maintenance. Construction material of shell, leaf-type elements and baffles is corrosion-resistant, glass-fiber-reinforced plastic. Element design leads to rapid buildup of filter aid and easier sluicing when washing. Maximum size offered is 720 sq. ft.—B-I-F Industries, Providence, R. I. 106B



### Graphite Tube Furnace

**Pilot-scale item has operating range to 5,000 F.**

Lindberg Engineering Co. has announced availability of a new high-temperature graphite tube furnace. Developed to meet demands for pilot-plant equipment capable of producing controlled high temperatures, the unit has an over-all operating range of 1,600 to 5,000 F.

Suggested applications include investigations into sintering of powdered metals, firing of ceramic bodies, and high-temperature chemical reactions.—Lindberg Engineering Co., Pilot Plant Equipment Div., Chicago, Ill. 106C



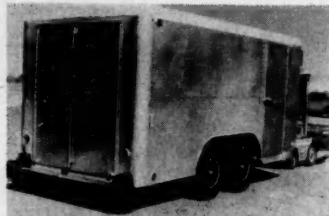
### Pipe Inspector

**Locates and measures defects within piping.**

Internal pits, bulges, coke or scale buildup, and concentric or eccentric corrosion are among the defects located and measured by the Tubescan 105 inspection instrument.

In operation, inspecting personnel place the probe in tube or pipe; the wheels and sensing elements are "dialed in" for desired size. As the probe is drawn through the tube at a moderate rate of pull, the sensing pattern advances about 1/8 in./revolution. This assures coverage of the entire internal pipe surface.

When a defect is located, a special circuit measures between 0 and 0.3 in. deep, to an accuracy of 0.01 in. The "105" is applicable to tube diameters from 2 to 10 in.—Union Industrial Equipment Corp., Port Chester, N. Y. 106D



### Portable Recorder

**Moves around plant or field to gather data.**

This portable, trailer-mounted recording room gathers data from an operating process, and records the information in digital form on tape for subsequent computer analysis. Known as the PDR-1, the unit accepts outputs of transducers measuring temperatures, pressures, flows, levels, etc.

PDR-1 can sample five separate channels of information at speeds up to 40 samples/sec./channel. It can also accept 60 individual signals and record them at rates up to 2 1/2 sec./scan. Over-all recording accuracy of signals with a 0.001- to 10-cps. frequency range is 1%. Tape output is compatible with commercial computers.—Southwestern Industrial Electronics Co., Houston, Tex. 106E

### Proportioning System

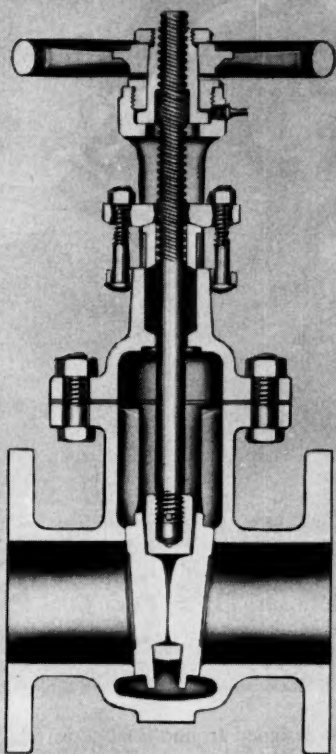
**Scale, feeder and controls for clay, other powders.**

Up to 3,000 lb. of 13 different materials can be weighed auto-

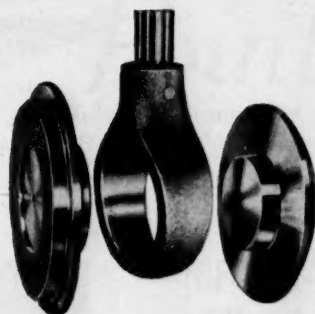
**EQUIPMENT  
NEWS**

Continues on . . .

**Page 193**

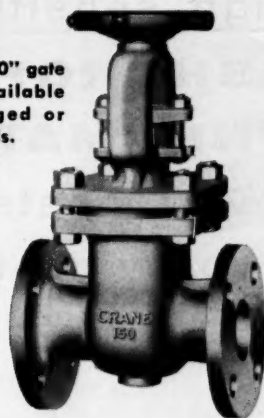


Sizes  $\frac{1}{2}$ " to 12"; 150 psi at 500 F,  
230 psi at 100 F



Crane split-wedge disc design. Identical disc halves assure uniform seating pressure.

"Craneloy 20" gate valve. Available with flanged or screwed ends.



## Exclusive design for lasting tight seating in "Craneloy 20" gate valves

The simple, unique split-wedge disc construction in "Craneloy 20" gate valves is the key to smooth operation, tight shutoff and long seat life.

Identical disc halves, exclusive with Crane, mean that seating loads are transmitted equally to each half, assuring uniform pressure on the seating faces. No danger of buckling—there's no weak disc member as in conventional ball and socket disc construction. In opening, the first turn of the handwheel frees discs—even if the valve is closed hot and opened cold.

Special guide flanges on the discs, *another Crane extra*, prevent disc drag across the seat during operation . . . give you longer seat life.

Discs are free to rotate to prevent seizing and galling.

All parts of the valve in contact with flow are "Craneloy 20," a high nickel, high chromium stainless steel cast in Crane's own foundries. Stuffing boxes are packed with tough, resilient, non-contaminating Teflon.

For complete information about all Crane stainless steel valves, see your Crane Representative.

Get complete specifications on "Craneloy 20" stainless steel valves. Ask your Crane Representative for Circular AD-2080, or write to address below.



# CRANE® VALVES & FITTINGS

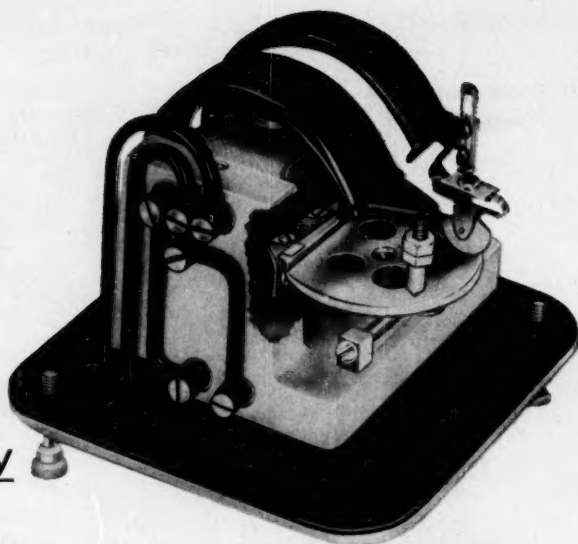
PIPE • PLUMBING • HEATING • AIR CONDITIONING

Since 1855—Crane Co., General Offices: Chicago 5, Illinois—Branches and Wholesalers Serving All Areas

**NEW**  
high sensitivity

## **ASHCROFT PNEUMATIC TRANSMITTERS**

lower costs...reduce maintenance  
...provide tighter control



Ashcroft Non-Indicating Pneumatic Transmitters are made in pressure and temperature types, each in regular and short span. Operation is on low-pressure air: output range, 3-15 psi or 3-27 psi.

These new transmitters are designed around (1) a powerful, efficient relay with sensitivity high enough to operate controllers, and (2) a simple, dual Bourdon tube motion-balance system. High sensitivity permits the use of narrowest proportional band settings on controllers and allows instant controller response to deviations from set point. With a shorter transmission lag, automatic corrective action starts before the deviation becomes critical.

In manual control systems, these new Ashcroft Transmitters (teamed with suitable receivers) make it practical to operate boilers at the most efficient level. In wet processing operations, fractionating columns yield a purer product. Highly suppressed Ashcroft Short Span Transmitters are so sensitive they can "judge" entire control loops and detect any errors in the system.

Basically a 6" cube, lighter than most 8½" pressure gauges, these climate-proof Ashcroft Transmitters are simple to install in cramped locations, are most readily accessible for adjusting or service. Calibration is extremely easy, with linearity checking entirely eliminated. Most parts in all types in the line are interchangeable. Ask your nearby Ashcroft Gauge Distributor about the lower initial costs and other savings that follow when you install Ashcroft Non-Indicating Pneumatic Transmitters. Send for Bulletin 361.



### **ASHCROFT PNEUMATIC TRANSMITTERS**

**A product of**

**MANNING, MAXWELL & MOORE, INC.**

*Consolidated Ashcroft Hancock Division • Stratford, Connecticut*

*In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*



SPROUT-WALDRON

# Pointers

for Mixing and Blending • Size Reduction  
Size Classification • Bulk Materials Handling • Pelletizing and Densifying

Published in the interest of better processing by Sprout, Waldron & Co., Inc., Muncy, Penna.



## GIANT MIXER TO BLEND 60,000 POUNDS OF STARCH

This huge Sprout-Waldron mixer has a capacity of approximately 2,000 cubic feet and is designed for handling a full carload, 60,000 pounds, of starch. Its inside dimensions are: 26' long x 10' wide and 18' high. Special railroad routing from Muncy, Pennsylvania to the Penick & Ford factory in Cedar Rapids, was required due to its unusual size.

Mixing is accomplished by means of a huge double ribbon agitator of complete welded construction. The agitator shaft rotates in heavy duty anti-friction pillow blocks mounted on outboard bearing shelves. The outside ribbon moves the material toward the discharge port, while the inside ribbon carries it in the opposite direction, resulting in a positive inter-mingling of material and rapid uniform mixing. Properly proportioned ribbons are welded

to supporting arms which are integrally mounted on the heavy shaft making it a rugged one-piece, durable assembly.

For further details on horizontal mixers, request Bulletin 128.

— SW —



**HAWAII BOUND** — the pulley, not the girls! This 60" diameter x 22" crown face split cast iron double arm conveyor pulley is one of two recently built by Sprout-Waldron for the Hawaiian Grain Corporation in Honolulu. The S-W line of standard and Belt Saver® pulleys finds extensive use in the process industries. Bulletins 33A, 35E available on request.

## UNIFORM MIXING KEY TO GOOD SPAGHETTI SAUCE

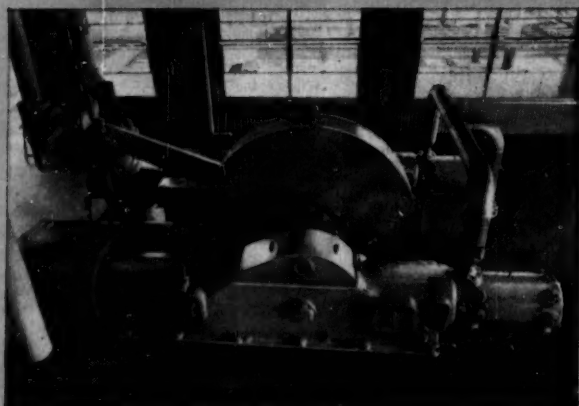


The directions on the colorful package of French's Italian Spaghetti Sauce Mix tell you to merely combine the ingredients in a saucepan, heat to boiling, simmer and stir and you have spaghetti sauce par excellence. What the package doesn't tell is the thorough pre-mixing job which assures that each package has the right amount of the right ingredients.

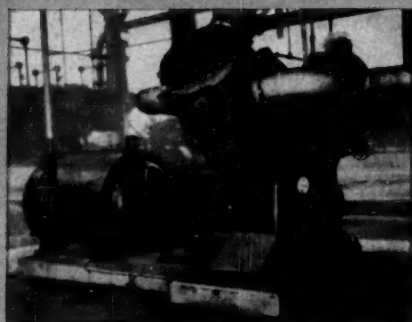
The key to successful mixing at R. T. French Company is the Sprout-Waldron Model 44 vertical mixer, designed to handle two tons of ingredients. Twenty different items in all, including dehydrated vegetables, sugar, salt, fat-free milk solids, cornstarch, spices and herbs are thoroughly blended for uniform packaging into one and one-half ounce air-tight paper bags.

The vertical mixer combines all the advantages of minimum floor space, maximum capacity per area as well as per horsepower with smooth, quiet operation and easy maintenance. For details on Sprout-Waldron's latest vertical mixer designs, request Bulletin 192. CP/113

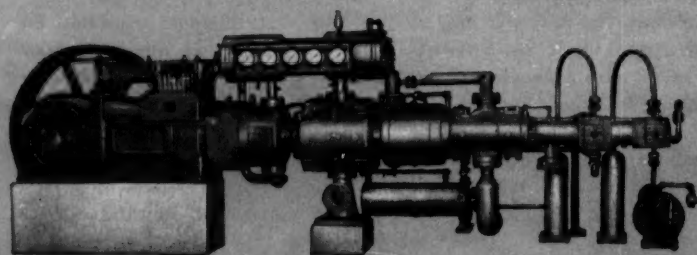
FOR EVERY PROCESSING REQUIREMENT  
THERE'S A **CP**  
**COMPRESSOR**  
MADE JUST FOR THE JOB



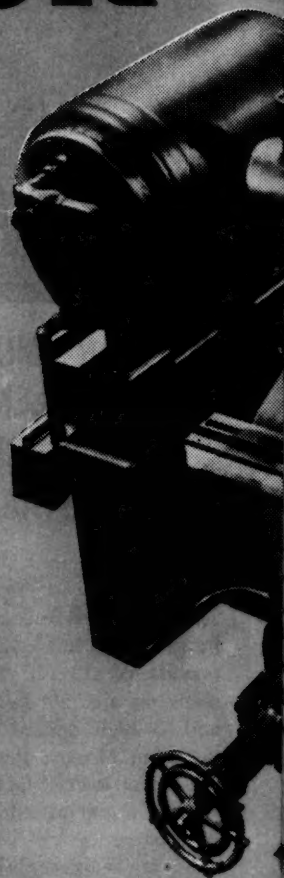
*Class "H", steam-driven, four-corner, single-stage hydrocarbon gas booster.*



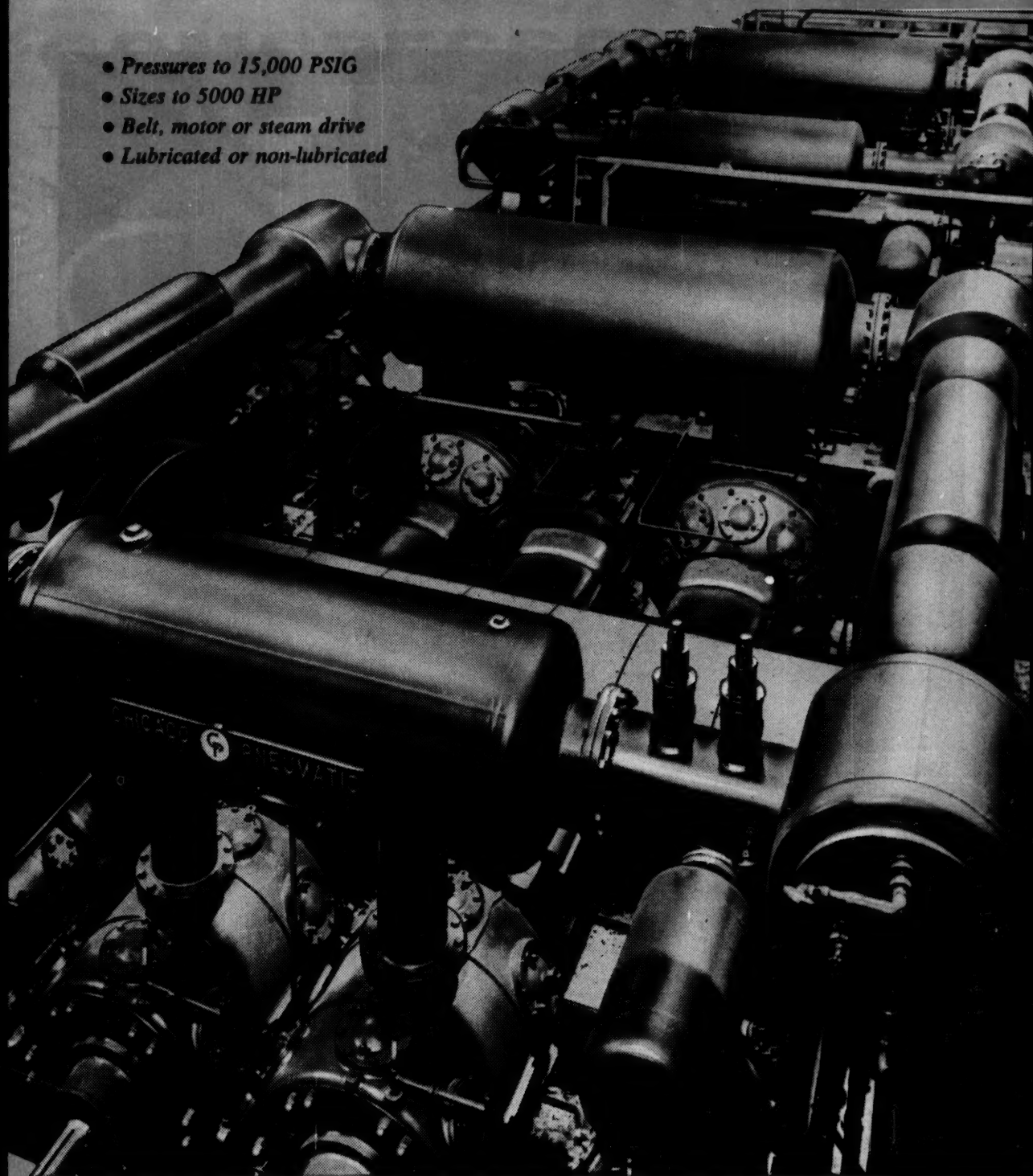
*Class "Y" butane compressor, coupled to an explosion-proof motor. In service in a large refinery.*



*Class "T", horizontal, straight-line, five-stage helium compressor. 6000 psig; 100 hp size.*



- Pressures to 15,000 PSIG
- Sizes to 5000 HP
- Belt, motor or steam drive
- Lubricated or non-lubricated



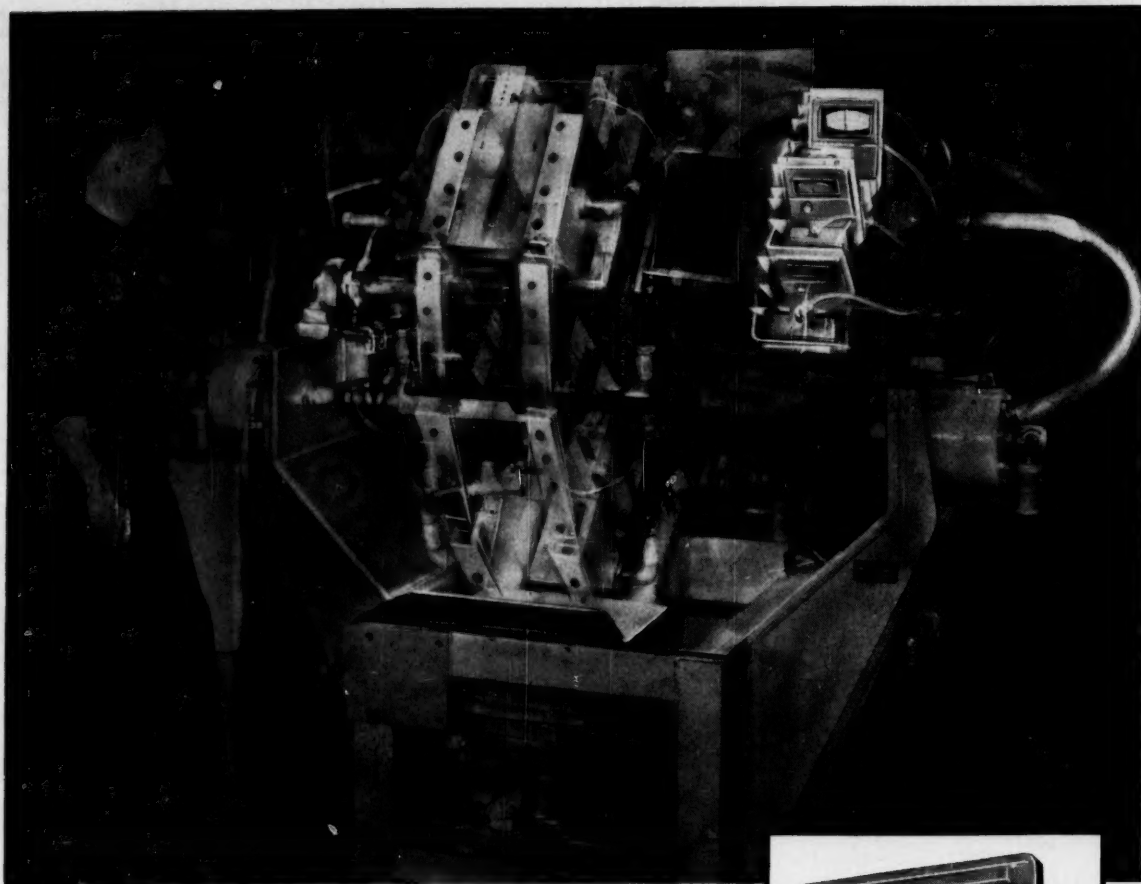
*Two Class "FE" balanced-opposed compressors in process work. 3500 hp; five-stage.*



**Chicago Pneumatic**

8 East 44th Street, New York 17, N. Y.

AIR AND GAS COMPRESSORS • VACUUM PUMPS • PNEUMATIC TOOLS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS



*A Partlow Model MFS indicating controller is shown in action in this "multiple exposure" shot of a Holo-Core Automatic Molding Machine manufactured by Spo, Inc., Cleveland, Ohio.*

## *The Temperature Control Built to* **SHRUG OFF SHOCK** *2438 Times a Day*

Every working day, the Partlow Temperature Control in this photo takes between 2400 and 2500 solid "roundhouse punches" from the shell-molding machine to which it is attached.

But despite jarring shock and vibration, and a constant barrage of foundry dust, the Partlow goes right on delivering precision control—without letup or breakdown.

Actually, only a control as simple and rock-solid as the Partlow could withstand this kind of punishment! Because only the Partlow contains no hairsprings, or delicate gadgets.

All Partlow thermal elements of the same range are interchangeable *on the job*, too. There's no time lost waiting for your control to

come back from the factory. And you get this extra margin of dependability *without loss of accuracy*. Partlow controls are precise to within 1% of scale in any one of 10 ranges from -30° to 1100° F.

If you use or manufacture equipment within this temperature range, there's a Partlow to fit your application exactly . . . and save you money, too. Available in Pneumatic, Electric or Self-Contained Gas types, in recording, indicating or non-indicating models! To field test any Partlow control . . . or to obtain full details write, The Partlow Corporation, New Hartford, N. Y. Dept. E-959.

Export: Ad. Anriema, Inc., 85 Broad St., New York 4, N. Y.



*A complete absence of gadgets and superfluous parts, as seen in this open view of the new MFS indicating control, explains the Partlow's unique ability to function accurately even under the most severe operating conditions.*

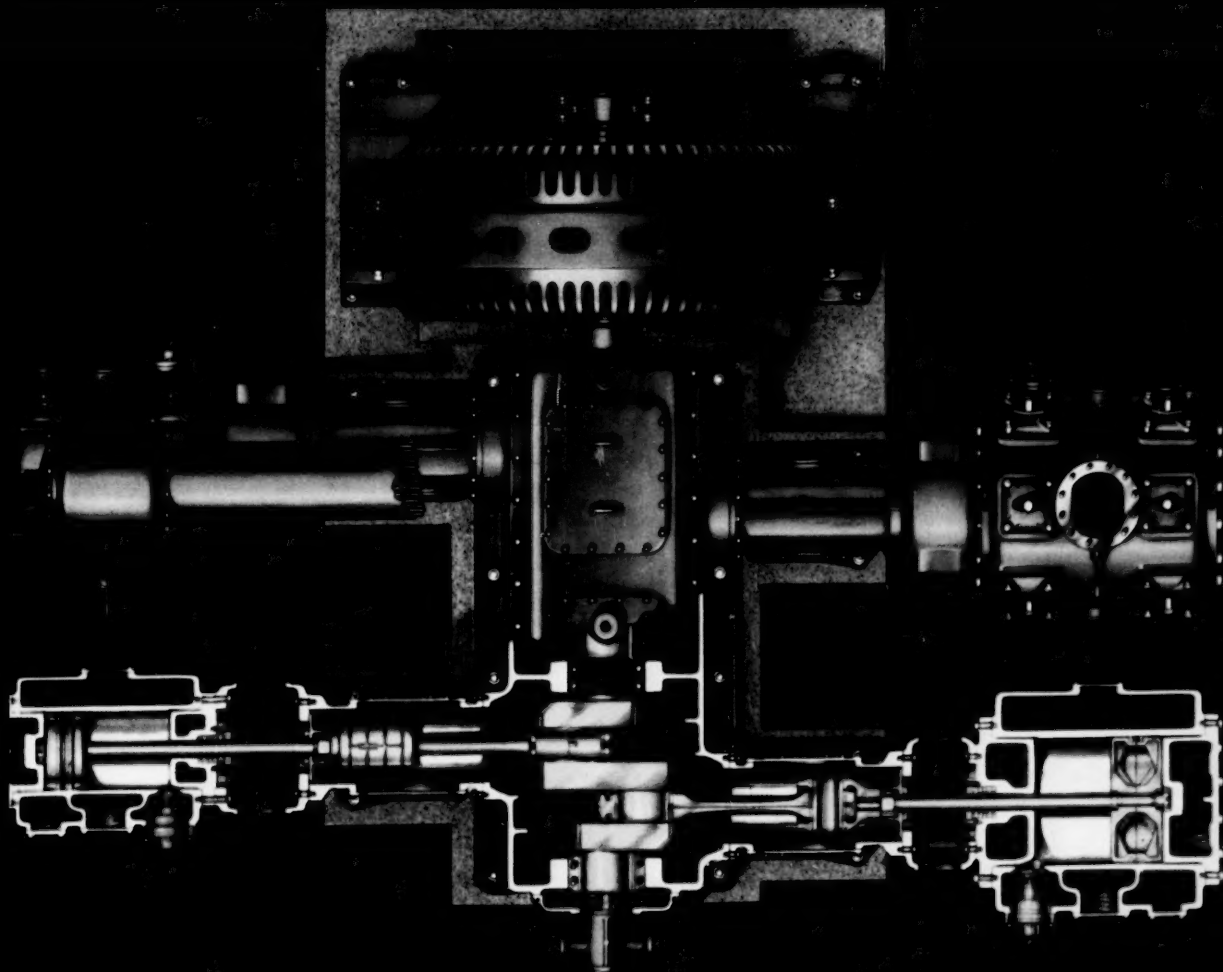
You can pay more but you can't buy better than

**PARTLOW**  
TEMPERATURE CONTROLS

# COMPRESSOR QUIZ

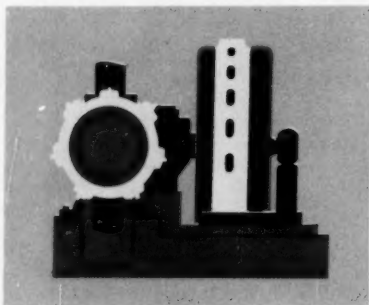
Take this 5 minute quiz and check your knowledge of balanced opposed compressors. . . . ANSWERS ON NEXT PAGE. NO PEEKING!

1. What is the reason for an outboard bearing supported motor?
  - ☐ Accessibility
  - ☐ Shaft alignment
  - ☐ Weight saving
2. Which design provides the smallest force couples?
  - ☐ Bearing between the crank throws
  - ☐ No bearing between the crank throws
  - ☐ Both are equal
3. Structurally, what's the critical point in the multi-crank horizontal compressor from a design viewpoint?
  - ☐ Lateral forces in the frame
  - ☐ Vertical forces in the frame
  - ☐ Cylinders
4. What type of motor is usually used on a balanced opposed compressor?
  - ☐ Induction
  - ☐ Engine-type synchronous
  - ☐ Wound rotor
5. Can machine-mounted coolers and inter-stage piping be factory pre-fitted?
  - ☐ Yes
  - ☐ No
  - ☐ Only on simple arrangements
6. Why is the balanced opposed compressor easier to install than other types of equivalent size?
  - ☐ Lighter weight
  - ☐ Less parts
  - ☐ Semi-packaged design
7. Is it common practice to install more than one compressor service on a single multi-cylinder frame?
  - ☐ Yes
  - ☐ No
8. Industry's most preferred compressor valve is standard with Worthington. It is:
  - ☐ A plate valve
  - ☐ A spring activated valve
  - ☐ A Feather Valve



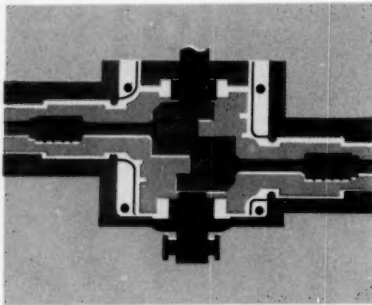
# ANSWERS

to key compressor questions on previous page



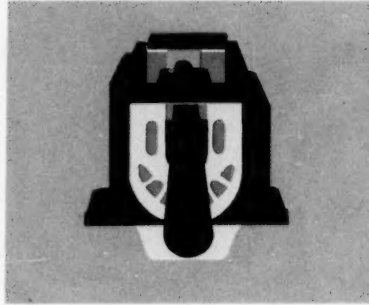
**1.** What is the reason for an outboard bearing supported motor?

**Ans:** Shaft alignment. Secure and permanent support of the large synchronous motor rotor is best obtained by placing a bearing on each side of the rotor.



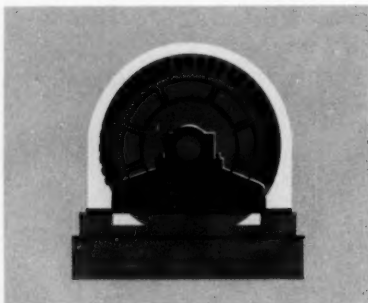
**2.** Which design provides the smallest force couples?

**Ans:** No bearing between the throws. Worthington's adjacent crank design reduces couple arm to a minimum.



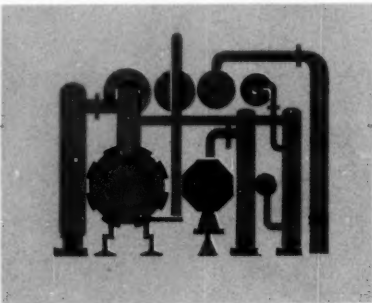
**3.** Structurally, what's the critical point in the multi-crank horizontal compressor from a design viewpoint?

**Ans:** Lateral forces in the frame which tend to distort the frame. Worthington's precision machined and fitted tie bars give solid support to the frame, preventing misalignment due to distortion.



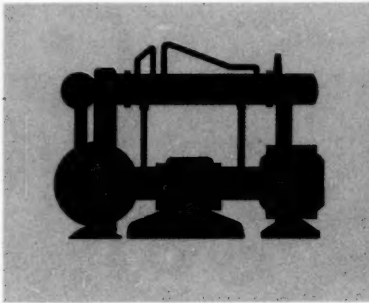
**4.** What type of motor is usually used on a balanced opposed compressor?

**Ans:** Engine-type synchronous is the major application; but complete flexibility of Worthington design permits use of any type driver, including turbine and gear or power engine.



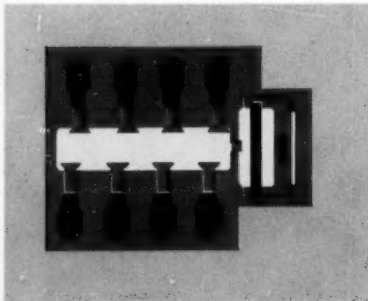
**5.** Can machine mounted coolers and interstage piping be factory pre-fitted?

**Ans:** Yes. In fact, when overhead mounted piping and coolers are furnished by Worthington, such piping and coolers are always completely assembled and fitted to the compressor before it leaves the factory.



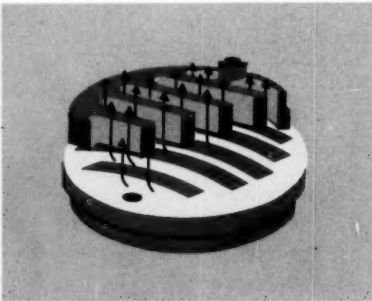
**6.** Why is the balanced opposed compressor easier to install than other types of equivalent size?

**Ans:** Semi-packaged design. Self aligning features permit easy and sure crank-shaft, frame, and motor alignment on simplified foundation. Pre-fitted coolers and piping eliminate many problems associated with multi-stage compressor installation.



**7.** Is it common practice to install more than one compressor service on a single multi-cylinder frame?

**Ans:** Yes. Particularly where the compression services are related, as in chemical plants. The arrangement results in substantial savings in initial plant cost.



**8.** Industry's most preferred compressor valve is standard with Worthington. It is:

**Ans:** Feather Valve! By actual count of 2 to 1, this outstanding compressor valve is preferred by operators and engineers.

**SCORING:** If you got 7 or 8 questions right you're up-to-date on balanced opposed compressors and you recognize the value of the Worthington machine. If you got 5 or 6 right you're acquainted with some of the benefits of Worthington equipment, but you need brushing up. If you got less than 5 right, get in touch with your nearest Worthington technical representative. He'll give you the full story on the many advantages of the Worthington design. Worthington Corporation, Harrison, N. J. In Canada: Worthington (Canada) Ltd., Brantford, Ont. 36.5



INSIDLINE® internal insulating systems for piping carrying gases at elevated temperatures and pressures, for service from 1000° F to 2000° F . . . ENHANCED® HIGH TEMPERATURE BLOCKS of pre-calcined diatomaceous earth, asbestos fibers and inorganic

**FROM A HIGH OF 2000° F**

and asbestos cement, for service from 100° F to 1800° F . . . B-E-H BLANKET INSULATION, felted mineral wool with different metal facings, for service from 100° F to 1000° F . . . B-E-H FILL INSULATION, granulated or block, for service from —150° F to 1200° F . . . SUPER POWERHOUSE® . . . service from 100° F to 1200° F

. . . NO. 100 . . . service from 100° F to 1200° F . . . NO. 101 . . . service from 100° F to 1200° F . . . 1200° F . . . service from 100° F to 1200° F . . .

. . . THERMASIL® calcium silicate insulation, for service from 100° F to 600° F . . . B-E-H ASBESTOS . . . service from 40° F to 700° F . . . B-E-H MONO-BLOCK® . . . service from 100° F to 1800° F . . .

THERMASIL® calcium silicate insulation, for service from —150° F to 1200° F . . . felts, for service from 100° F to 1800° F . . . THERMALITE® 85% microcellular foam pipe insulation . . . GEM-FIL polyurethane . . .

. . . B-E-H ANTI-SWEAT . . . to 100° F . . . B-E-H FROST . . . 600° F . . . B-E-H STANDARD . . . from 100° F to 275° F . . . FLAME-CHEX® . . . B-E-H RITE-TEMP . . . PERIMSUL mineral wool pipe insulation . . . GEM-FOAM® . . . —460° F

. . . B-E-H ANTI-SWEAT . . . to 100° F . . . B-E-H FROST . . . 600° F . . . B-E-H STANDARD . . . from 100° F to 275° F . . . FLAME-CHEX® . . . B-E-H RITE-TEMP . . . PERIMSUL mineral wool pipe insulation . . . GEM-FOAM® . . . —460° F

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**DOWN TO ABSOLUTE ZERO**

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**INCORPORATED**

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DEVELOPMENTS ...

## PROCESS FLOWSHEET

R. A. LABINE



For gasoline additives and plasticizers . . .

## Flexible Processing Steps Net TCP

**T**URNING out 29 products at a combined 20-million-lb./yr. rate from only three batch reactors challenges the ingenuity of both plant designer and plant operator. This is exactly the problem met by Celanese Corp. of America's versatile plant at Point Pleasant, W. Va.

One of the plant's major products is tricresyl phosphate, best known as a gasoline additive but which also has many plasticizer applications. Among the other products are a host of other esters used for plasticizers, hydraulic fluids and fire-retarding chemicals.

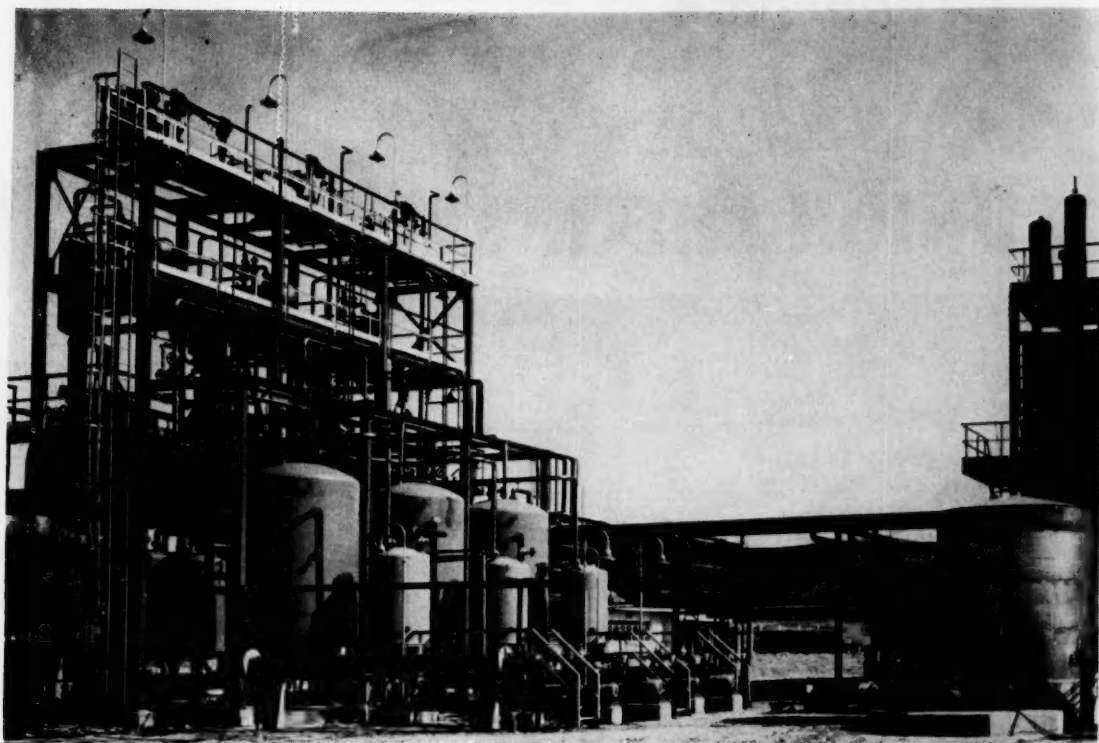
Now for the first time in print, Celanese outlines the processing tricks that go into the manufacture of tricresyl phosphate.

► **Endless Variety**—The name tricresyl phosphate actually refers to a wide variety of compounds. Few of the phosphate esters produced by Celanese are pure compounds but rather are controlled blends which have the desired physical properties.

Reason for this variety is that commercial cresylic acid—one of the starting materials—contains all of the substituted hydroxybenzenes between phenol and trimethylphenol. Final ester

Unfold Flowsheet





TCP REACTORS, spherical batch stills and intermediate tankage are all located in the structure on the left.

characteristics such as specific gravity, viscosity and molecular weight are largely determined by the particular cresylic acid cut charged to the reactor. Variation in finishing steps can also alter ester properties to some degree.

► **Problems in Batches**—Because of the wide range of products produced at Point Pleasant, batch processing is required to furnish the needed flexibility. But this also presents a variety of problems. Besides production scheduling (which is a considerable challenge in itself), there is the problem of selecting materials of construction which will stand the wide variety of processing conditions.

Because hydrogen chloride is evolved in many of the reactions, extensive use is made of nickel, impervious graphite and glass-lined equipment. Two of the reactors are glass-lined and one is stainless steel. Phosphorus oxychloride, one of the starting materials for TCP, is stored in nickel-lined tanks prior to use.

Hydrogen chloride off-gas is absorbed by water in an impervious graphite system to make com-

mercial-grade muriatic acid—the plant's principal byproduct.

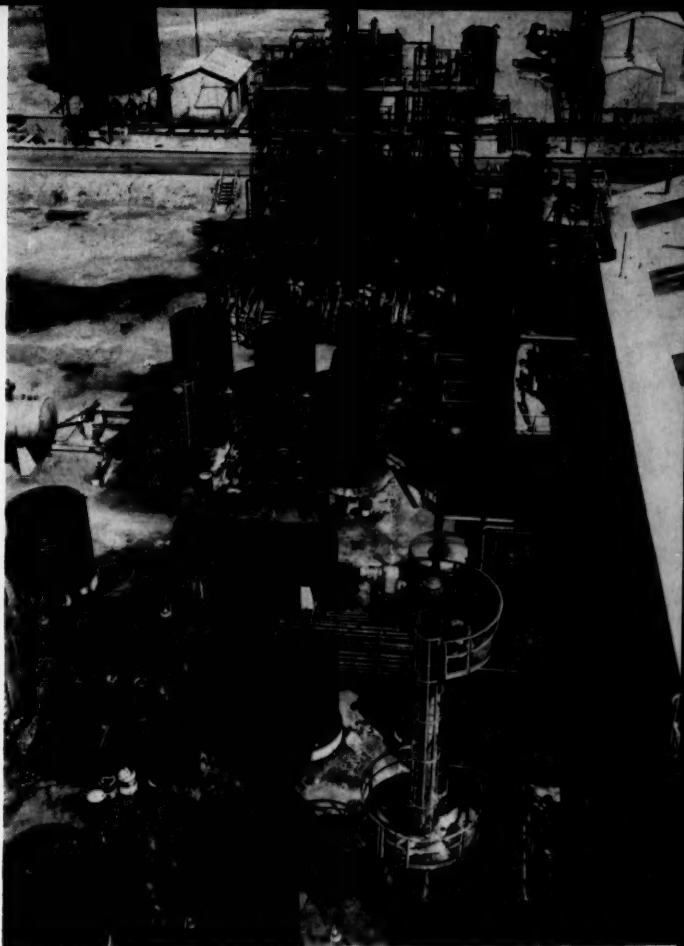
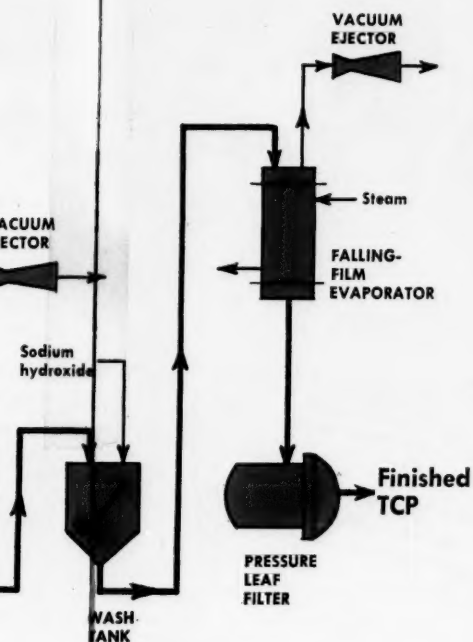
► **Initial Reaction**—Crude TCP is produced in a glass-lined reactor, then is refined by batch distillation, washing and evaporation.

One mole of phosphorus oxychloride reacts with three moles of commercial-grade cresylic acid at about 500 F. to yield one mole of TCP and three moles of hydrogen chloride. Hydrogen chloride is fairly insoluble in the crude ester and evolves from the reactor at 5 psig., flowing to the HCl absorption system.

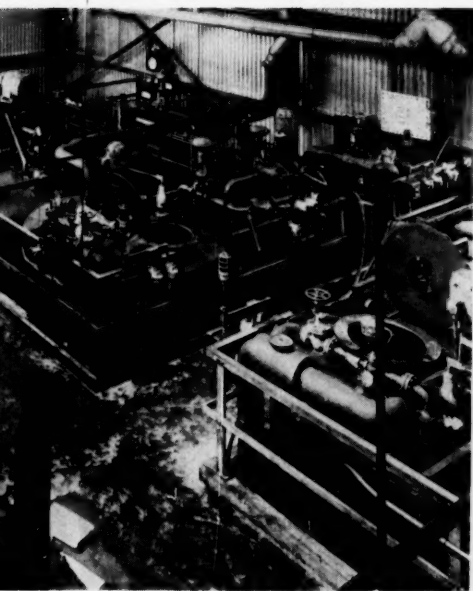
Crude reactor product is then batch-distilled to separate the unreacted cresols which can be recycled. The 3,000-gal. batch stills are nickel-clad because of the trace amounts of HCl remaining in the crude reactor product. Spherical shape was picked for mechanical strength since the pressure difference between the Dowtherm jacket and process side may be as great as 100 psi. at 700 F.

Condensers and piping handling the light ends are fabricated from nickel. Evacuators and related condensers in vacuum system are

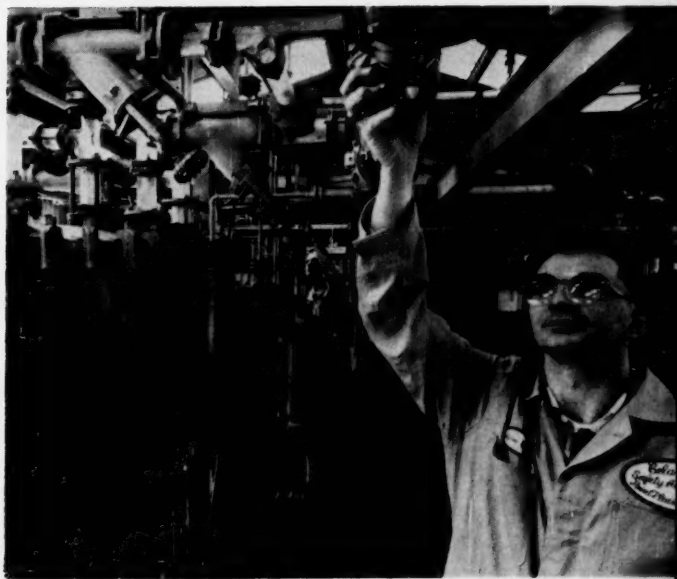




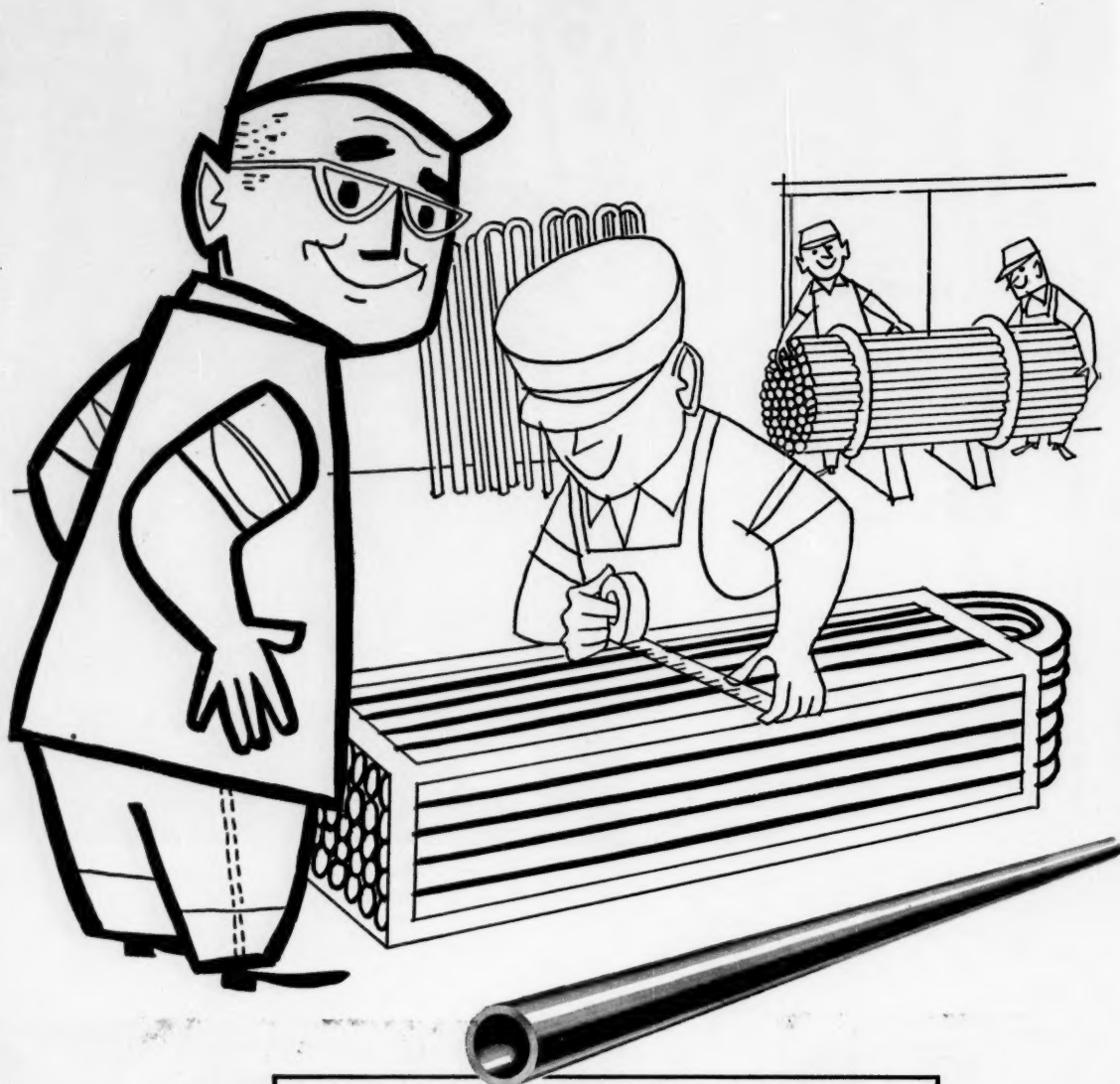
MAZE of tanks and piping shows plant's accent on flexibility.



le TCP by contacting with caustic and then water  
left eliminates last traces of salts in the product.



REACTORS in pilot plant test out process variations. Equip-  
ment can also turn out small-volume items in emergencies.



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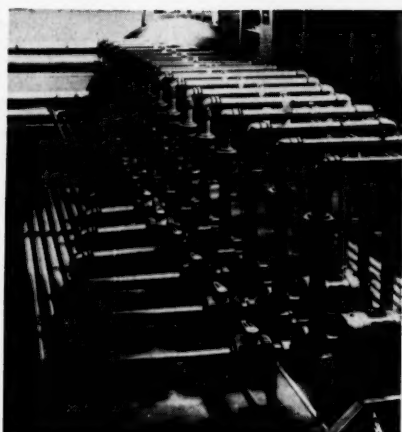
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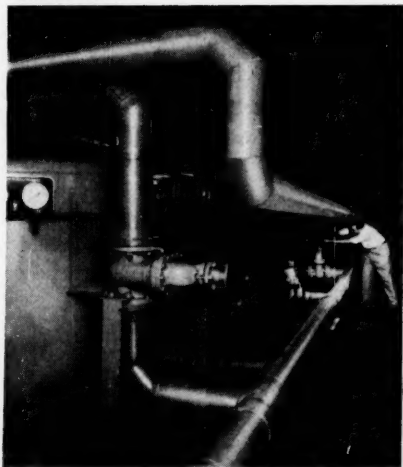
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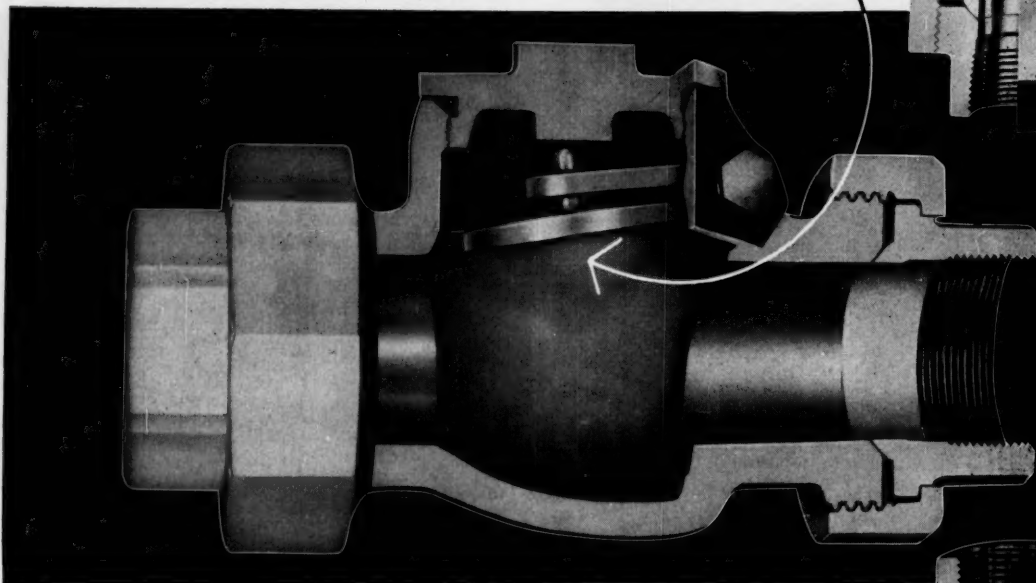
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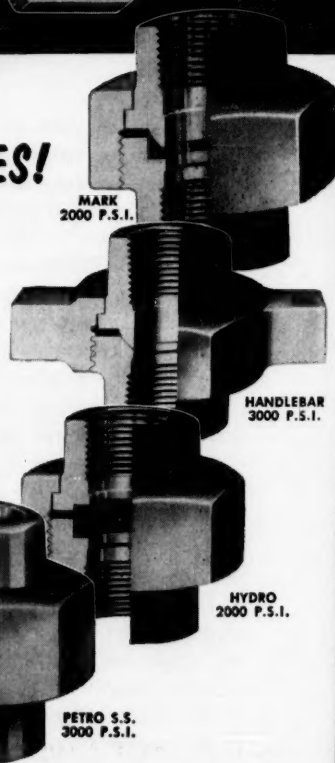
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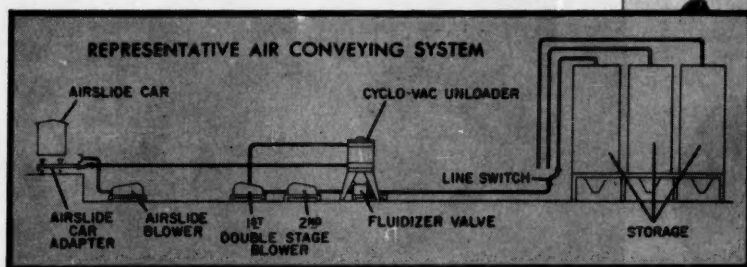
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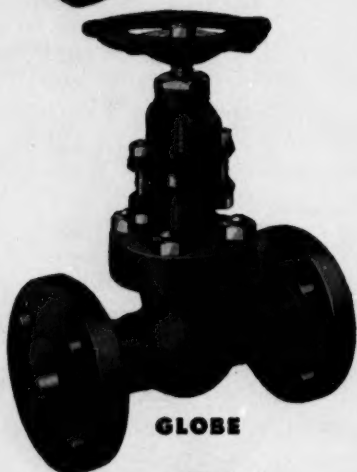
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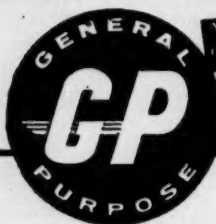
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JOHN R. CALLAHAM now editorial v.-p.



CECIL H. CHILTON now editor-in-chief.

## Meet Our New Top Echelon

ON SEPTEMBER 1, two people who have had a large hand in *Chemical Engineering's* success left us—one to go on to a higher position in McGraw-Hill; the other, to retire.

John R. Callaham, editor-in-chief since May 1950, moved up to become vice-president and editorial director of McGraw-Hill Publishing Co.'s publications division. James A. Lee, Southwestern editor, former managing editor, and 31-year veteran of *Chemical Engineering*, retired the same day.

Appointed as *Chemical Engineering's* new editor-in-chief is Cecil H. Chilton. Fifth to hold this post in *CE's* 57-year history, Cecil joined the staff as an associate editor in December 1950. In his most recent position as Editor, Engineering Develop-

ments, he edited the *Chemmentator* and supervised the operations of all news and new-product departments.

To replace Jim Lee in the Southwest, we selected Thomas H. Arnold, Jr. Like Jim a Southerner, Tom is widely acquainted in the area. A former assistant editor in New York, Tom has been with Jim in Houston since June, "learning the ropes."

To handle Cecil Chilton's old job as Editor, Engineering Developments, Calvin S. Cronan has moved up from associate editor. Cal has been a member of the *CE* staff since 1952. For several years past he has been Cecil's second-in-command in the "engineering developments group."

Then, filling in the vacancy thus produced in the developments group,

### Those Who Stepped Up:

**John R. Callaham, Vice-President and Editorial Director**—John is the second editor of *Chemical Engineering* to become company editorial director. A ChE graduate of the University of South Carolina, John started his career with General Chemical at Marcus Hook. After six years with General, he joined the *CE* staff in 1941.

Quite soon, John was sent to San Francisco as Western editor. There he started and carried on a special *CE* supplement for readers in the 11 western states. In 1949 he was recalled to New York as executive editor, then was named editor-in-chief a year later. He belongs to AIChE and SCI and is a licensed chemical engineer in California.

**Cecil H. Chilton, Editor-in-Chief**—*CE*'s new editor-in-chief was already well known among chemical engineers for his work on cost estimating before he joined our staff. In April 1950 an article of his in *CE* revealed a cost estimating method now widely accepted in the profession. Soon after his article appeared, he left Du Pont to join the *CE* staff. In 1957, he was named Editor, Engineering Developments, with editorial supervision of all news and new-product departments.

Cecil's Bachelor's in chemical engineering was earned at Alabama Poly, and his Master's at Carnegie Tech. He has served as president of AIChE's New York Section, is active in the national organization and is at present treasurer of the American Association of Cost Engineers. Last year he was recipient of the AACE's first annual Award of Merit.

**Calvin S. Cronan, Editor, Engineering Developments**—Cal joined *CE* in 1952. A New Englander and chemical engineering graduate of Northeastern University, he gained industrial experience with Dennison Mfg. Co. and Bird Machine.

Following a period where he handled all sorts of editorial work for *CE*, Cal became Cecil Chilton's right-hand man in the Engineering Developments Group, with primary responsibility for the Processes and Technology section. He's an officer of the New York Section of AIChE and a member of ASME.

**Thomas H. Arnold, Jr., Southwest Editor**—With both BS and MS in chemical engineering from Louisiana State, Tom worked for Esso, Ethyl Corp., Niagara Chemical Div. of Food Machinery & Chemical, and served a stint in the Army Chemical Corps before joining *CE* in 1957. He handled and wrote feature articles and was first editor of the *CE* Cost File. Since he is a Southerner and had had most of his experience in the South and

T. Peter Forbath has been recalled from his Chicago-based job as Midwestern editor to rejoin the New York staff as associate editor. Before transferring to Chicago last year, Pete was an assistant editor in Cal's group, primarily responsible for the Process Flowsheets.

Well before June, Tom Arnold's replacement on the New York staff was selected in the person of Peter J. Brennan. Peter joined us late in June, coming from Westinghouse where he had worked as a chemical engineer on power reactors for the Navy.

In losing John Callaham as editor-in-chief, we shall not completely lose his sure editorial touch. With his promotion into company management, as vice-president and editorial director John will oversee the editorial performance of some 40 McGraw-Hill publications, including our own.

John's advancement is a recognition of outstanding service during his 18 years with *CE* and his nine-year tenure as editor-in-chief. During the nine-year period, the magazine's circulation increased by one-third; its number of engineer-editors was more than doubled; its frequency went from monthly to biweekly; and many innovations were added, including such features as *You & Your Job*, the *CE* Refresher, the *Process Design Notebook* and the *Operation & Maintenance* department.

Brief biographies, at the left, for most of those involved in these changes, will help you to become better acquainted with them. You will find a sketch of Jim Lee's career on page 152, along with his article on Freeport Nickel's Moa Bay and Louisiana operations. This article was Jim's last assignment in his long tour of duty on the *CE* staff.

In gaining Cecil Chilton as its new editor-in-chief, the magazine will be headed by a man well known to many chemical engineers and eminently qualified for the position. Backed by a staff which includes more engineers than all other CPI technical publications combined, we feel the magazine he heads will continue to earn your high regard.

*Dwight F. Grandly*

PUBLISHER

Southwest, Tom was a natural choice to succeed Jim Lee as Southwestern editor on the latter's retirement.

**Peter J. Brennan, Assistant Editor**—Two months ago Peter joined the *CE* New York staff to replace Tom Arnold. He is a chemical engineering graduate of Catholic University and gained his industry experience with Union Bag & Paper, Standard Brands, Stauffer Chemical and Westinghouse. This experience ranged from pilot plant work, through process engineering and chemical plant supervision, to design and specification work on valves for nuclear reactors. His *CE*

activities will be mainly in the engineering-article area.

**T. Peter Forbath, Associate Editor**—When his Army service was completed in 1956, Pete joined *CE* in New York as an editor in the news and process flowsheet area. Previously, he'd earned his BChE at Brooklyn Poly and had worked for North American Aviation on missile fuel development. In 1958 Pete transferred to Chicago as Midwestern editor. Now he is returning to New York as associate editor to handle *Chemotator*.

Pete's successor in the Chicago area will be John M. Winton.

# computers

# A CHEMICAL ENGINEERING REPORT

It's difficult to get a valid assessment of the influence of computers throughout the chemical processing industries. Our primary intent in querying computer experts was to determine their use of machines in engineering and scientific application. Many processing companies, however, have machines that are used for both business and engineering purposes, or solely for business purposes. In our census mailing, we confined ourselves only to installations that we knew were primarily used in technical work.

### What Computers?

About 150 computer installations were covered in our census. The computers represented include analog and digital, of sizes from small through large. Our figures indicate that there are at least five digital computers for each one analog computer used for technical work in these processing companies.

Few of our respondents, however, are gloomy about any computer's future. In the next decade, they see an increase within their companies in the use of all computing machines—general and special purpose, digital and analog.

This increased use will presumably come about as a result of pressures both internal and external to a company's operations. The internal pressure will come as more engineers become familiar with the power of the computer in solving their problems. As one expert puts it: "A more general recognition of the capabilities of computers on a personal basis [will increase their use]." Although the typical chemical engineering curriculum does not include required exposure to computer techniques, the widespread availability of computers in the universities will eventually permit the young engineer to carry computer techniques into his work.

The external pressure is economic. Extrapolation of population growth over the next several decades shows that although the consuming portion of our economy will increase greatly, the percent producing will decrease. This means that greater productivity of industry—demanded by more consumers wanting more things—must

pick up the slack. And computers, by making possible the impossible (of a pre-computer era), will surely help tighten things up.

The other external economic pressure is, of course, competition among chemical makers. There is no rational way of evaluating dollar value added by computer use, but it's evident that those companies most aggressively exploiting computers—finding new technological applications, finding uneconomic practices within their operations, finding the best way to do things—will get big payoffs.

### What Problems?

Computer experts, and the engineers who feed problems to them, don't lack any imagination in the kinds of problems they attack. The response to our questions shows many more problems than computers.

Problems range from what you would consider straightforward engineering calculation to sophisticated analyses and syntheses. It's impossible to list all the problems that processing companies use computers to solve, but the table gives a hint of them. It seems that we'll never run out of possible problems—the only question is whether, even with computers, we can keep up with those suggested.

To solve these problems, and hundreds of others, it's necessary to have explicit instructions (a "program") for either the analog or digital computer. Many of these problem-solving programs are generated within the computer users' installations. But companies have found that it's economic to ex-

change programs with each other when those programs are of particular mutual interest.

Consequently, user groups—organized to facilitate interchange—provide such a service. Another newer service is being provided by the Machine Computation Committee of AIChE. This group began, in May of this year, to publish program abstracts submitted to the committee in *Chemical Engineering Progress* for possible later amplification as program manuals. Respondents to our survey indicate that this service is welcome in computer facilities.

### What of the Future?

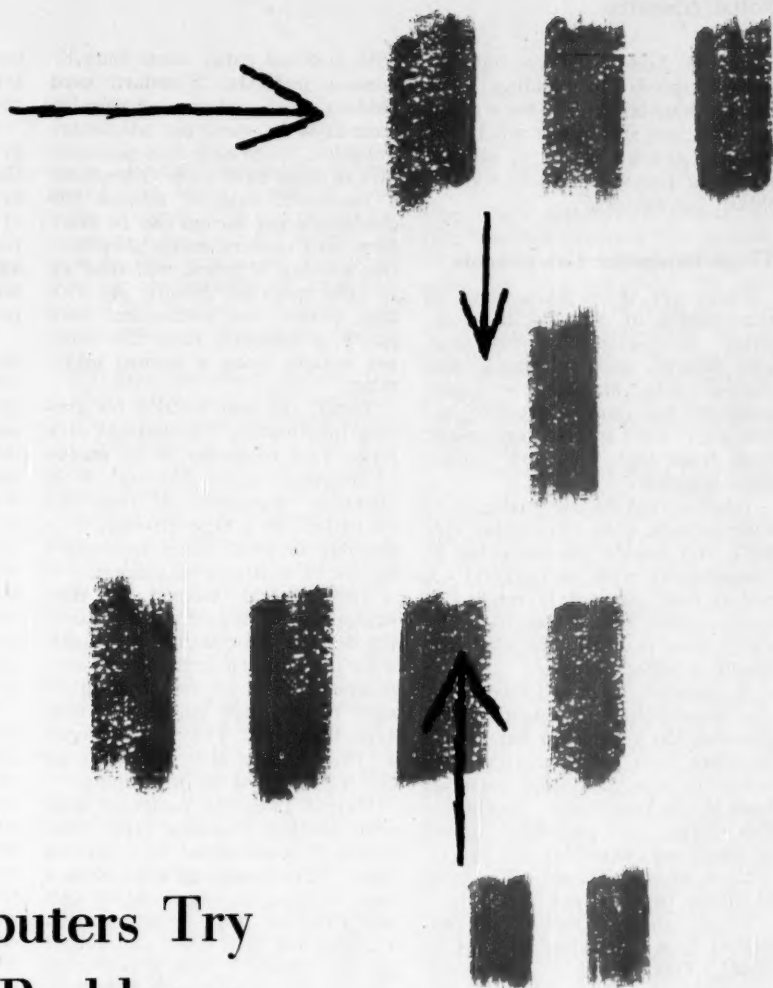
The future of computer use for engineering problems depends on action to meet several needs cited by the experts. Education of company personnel is most often voiced (and we hope to help some, in that respect, with this Computer Report). But other factors include the need for development of more-universal computer languages to facilitate solving the same problem on different computers, more mathematics training in engineering curricula, better administration of computer centers, better distribution of available computer programs, development of faster computer equipment and—noted several times—just the passage of time.

Of the equipment that is or should be available for the processing industries, they note: "We need a small, portable, reliable, cheap digital computer for experimental use," and "We need a small computer for 'individual' problems." Others emphasize cost: "We need computing ability at substantially decreased cost," and "We need a much faster scientific computer . . . at reasonable cost." And from several came the opinion voiced by one respondent: "The manufacturers are ahead of our ability to use computers now."

The CPI computer census is in, and although we don't claim it's comprehensive, we do think it's representative of the best computer-user opinion in the chemical processing industries. The Report that follows is our effort to key you to the use and understanding of these engineering tools they discussed—the electronic computers.

### Use Computers Here

- Analytic instruments calculations
- Plant material balances
- Estimation of chemical & physical properties
- Design of multi-feed, multi-draw distillation columns
- Statistical analysis of operating data & designed experiments
- Reactor simulation
- Heat exchanger rating & design
- Discounted cash flow
- Process performance calculations
- Control system studies
- Piping network fluid-flow analysis



## Digital Computers Try Engineering Problems

In chemical reaction kinetics.

In chemical unit operations.

In plant operation economics.

**WILLIAM E. BALL, Monsanto Chemical Co., St. Louis, Mo.**

**D**URING the last year, how much of your time have you spent at a desk using a slide rule or calculator? How much of this time was spent doing some routine, repetitive calculation such as checking a material balance in some process? This is just one type of calculation for which digital computers have been used many times with great success.

The appearance of a large computer, with many units spread out over a huge room, is often enough to convince the novice that it's impossibly complex. We would like to show that computers are definitely not too complex for you to understand and that it does not take a lot of training to make use of them.

In our discussion we will consider only "stored program" computers.

Stored program computers have operating instructions stored within them. The "program" is the set of instructions which the machine follows to solve a problem. The "programmer" is the person who actually writes the program.

The smallest computer can solve the same problems which the biggest machines work on. Primary purpose of bigger machines is not

increased logical power but increased speed. In deciding what size machine is required for a given problem, you should ask not if the problem can be solved at all but how long you will have to wait to obtain the answer.

### Three Computer Components

There are three main types of components in any digital computer: input-output devices, storage devices, and arithmetic and control units. Making a complete computer will require selecting, essentially, one specific equipment item from each type and joining them together.

Input-output devices enable us to communicate with a computer (input) and enable the computer to communicate with us (output). A widely used, elementary method to communicate with a machine is by using some manually operated keyboard or set of switches.

A common manual keyboard is the input-output typewriter. Depressing the typewriter keys sends impulses into the computer. The computer can also send impulses back to the typewriter. Speeds for this output are generally limited to about ten characters per second. This is slow compared with other available input-output means.

Often another device is connected to a typewriter or used by itself. This device is a punched-paper-tape reader and punch. The punched tape has a code of punched holes to represent numerical and alphabetical information. Tape, read by a photoelectric reader, can be used for rapid computer input. Speeds of 200 characters per second are common. However, punching the tape is usually considerably slower since it is a mechanical operation.

It is possible to get information into a computer much more rapidly

with punched paper cards than by manual methods. Standard card readers that obtain information from up to 400 cards per minute are available. Since each card may contain as many as 80 or 90 characters, a maximum rate of around 600 characters per second can be read. New card readers, using photoelectric sensing of holes, will read up to 1,000 cards per minute. As with tape punch, the mechanical card punch is relatively slow, 200 cards per minute being a normal maximum.

Today, the best method for getting information into and out of a large, fast computer is by means of magnetic tape. Although it is normally impossible to read the characters on a tape directly, it is possible to print these characters by use of auxiliary equipment.

The general method of tape equipment use is to manually punch the desired information into cards. This information is then read onto magnetic tape by combination of card reader, tape control unit and tape drive unit. The tape produced in this manner then functions as the input to the main computer.

Output from the computer goes onto another magnetic tape, from which it is converted to a printed page. This is accomplished with a tape drive unit, tape control unit and a printer. Rate of information transfer for both input and output in the standard tape drive units may be 15,000 to over 90,000 characters per second.

We've already mentioned the printer which produces the usually desired printed page. These printers can be used with off-line tape equipment or directly with the main computer. Speed of printing ranges from 150-1,500 lines/min.

### Inside the Computer

In discussing input-output devices, we have assumed that a number read by the computer will have some definite destination inside the computer. This destination is the internal storage used by the computer so that information will be directly available when it's needed during computation.

The most common type of internal storage is provided by magnetic drums. These drums may be thought of as short pieces of magnetic tape formed into continuous loops. The drums move at con-

stant speed, and therefore the information recorded on them at any point is always rapidly available.

The time it takes to recover any given piece of information from the drum depends on how long you must wait for it to pass under one of the magnetic "read" heads surrounding the drum. On the average, this time varies from slightly less than one millisecond to over 15 milliseconds.

These times, short as they seem, actually fall into the range of "intermediate-speed" computers. Drums are used as the main storage unit in computers operating at intermediate speeds. When faster machines are needed, we no longer want to wait for the moving drum to bring the magnetically stored information to the read heads. Instead we want the information to be available immediately. Since this means that any one part of storage is always as available as any other part of storage, we refer to it as "random-access" storage.

The magnetic core, a minute piece of magnetic material shaped like a doughnut, is the device which has almost completely taken over the job of high-speed random access. On tape and drum, information is recorded as magnetic spots on a physically moving surface, the motion bringing the spot to where it can be read. Magnetic cores, on the other hand, record information in a definite fixed physical spot which is capable of being individually selected and read. This means that we have only to wait for electronic selection of core posi-

Bits Fix Digits—Table I

Bit Pattern	Decimal Digit
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9



tion in order to get information from memory. Speeds of access now range from 24 microseconds down to a possible 0.5 microsecond. Physical size of these magnetic core memories is not large since each core measures only a few hundredths of an inch in diameter.

We mentioned that drums are of intermediate speed and cores are of high speed. Are there any slow speed units and why are they used? In a sense, the card or tape input to a computer is slow storage since it allows the computer to obtain data when needed. However, there are two different units now available which were designed to furnish a very large volume of reasonably random-access storage, although at slower speed than a drum device.

The first of these—the faster of the two—consists of magnetically coated revolving disks. These may be thought of as a magnetic drum that has been sliced up and the information recorded on the surface of the slices. This information is recovered by a read head which physically moves in and out over the disks until the desired radius is reached. Motion of the disk will bring the desired information around under the read head. Provision is made for moving the entire read head assembly from one disk to another.

The second of these slow units, although slower than the disk file, has a larger capacity. It is a tape file containing 50 tapes, each 250 ft. long. Information is recovered by a read head physically moving into position over one of the 50

tapes. The appropriate tape is then moved just as in a regular tape drive. Instead of having to search through one 2,400-ft. length of tape to find any given group of data, we can immediately go to the correct 250 ft. length of tape, thus considerably cutting down search time.

We have discussed devices for getting information into and out of a computer and also for storing the information inside the machine. We call parts of the computer which actually use the information and which generate the required answers the arithmetic and control units. The arithmetic part does all of the required adding, subtracting, multiplying, etc., in a unit called the "accumulator."

The control unit directs the required operations, after first deciding what operation is needed. For example, when adding, the control unit obtains the numbers from the storage device and directs the result from the arithmetic unit back into the computer storage.

### You Need a Language

Basic to operation of the arithmetic unit is the method of representing numbers in the computer. What are the methods of getting information into the computer? Input devices may punch holes into a card or paper tape or place magnetic spots on tape. In any case, a pattern of spots or blank spaces represents the problem information. It is this pattern of spots, or "bits" as they are called, which is

actually used by the computer.

How is the pattern of information stored internally? The drum, like the tape, accepts the pattern of bits as magnetized spots. In cores, on the other hand, the pattern of bits is stored with each individual bit represented by an individual core. State of the magnetic field around the core tells the computer whether the bit represents an original information spot or a blank space.

Notice that what must be represented is whether a hole was punched or not, whether a magnetic spot existed or not. We usually represent this choice by a zero for no hole (or spot) and a one for a hole (or spot). If, for example, we have punched paper tape which has space for four possible bits (i.e., holes to be punched across the width of the tape), we may represent decimal digits by the code shown in Table I. In the bit pattern column of the table, a zero means no hole punched while a one indicates a hole.

Of course, it's not necessary to use punched paper tape with this representation. The bits could just as well stand for magnetic spots on tape and drum or for the magnetic state of a core. It takes four individual magnetic cores to represent a decimal digit, since one individual core represents one bit.

The pattern of Table I is widely used in computers today and is called "binary-coded decimal." Since we are representing decimal numbers by a code, part of the name is obvious, but what is the significance of the word "binary?" Pro-



gression in this code is equivalent to counting in the binary number system, the base of which is 2, rather than in the familiar decimal system, the base of which is 10. Each time, in binary arithmetic, that you shift one digit position to the left in the pattern, the value of the number is multiplied by 2. For example, the decimal number 9 becomes, in binary

$$\begin{aligned} 9_{10} &= 8 + 1 \\ &= (1 \times 2^3) + (0 \times 2^2) + (0 \times 2^1) + (1 \times 2^0) \\ &= 1001_2 \end{aligned}$$

where subscripts indicate the base. We may express larger numbers, such as 1959, in binary coded decimal by grouping the bits for each digit separately.

Decimal:	1	9	5	9
BCD:	0001	1001	0101	1001

The computer handles the number in this latter form.

Before we discuss how a computer actually solves a problem, let's first emphasize something about numbers. If we want to add two numbers together, we must have the decimal points at corresponding positions in both numbers or our answer will be meaningless. Most computers use and store numbers as a fixed group of digits called a computer "word." Word length, i.e., the number of digits in the fixed group, generally is about 10 digits. What is actually stored in a magnetic drum for the number 1959 is

$$+0000001959$$

in decimal. We also prefix an extra bit to indicate the sign of the number (zero for plus; one for minus). If, to our number, we add another number to form a sum

$$1959 + 23 = 1982$$

then in order for the sum to be correct, the 23 is stored as the number

$$+0000000023$$

In any lengthy problem this checking of decimal point locations is a tedious and time-consuming job. To help eliminate this difficulty, a method of computer operation called "floating-point" arithmetic has been developed. With this method the machine itself keeps track of the decimal point locations for all of the numbers and always gives the correct answers, even if initially they have been incorrectly aligned.

The floating point concept had

its beginning in the exponential form of writing numbers. Using this form, our number 1959 would be

$$+0.1959 \times 10^{+4}$$

If we represent all numbers in this way, the exponent will enable us at all times to determine where the decimal point is located. Naturally we want to store this one number as one word in the computer, but what about the sign of this number? Notice that there are two signs involved—the sign of the number and the sign of the exponent. In most decimal machines, this problem has been resolved by the artificial device of always adding 50 to the exponent in order to make it positive. Thus

$$1959 = +54 \ 19590000$$

Notice that in the ten digit computer word the sign is the sign of the number, the first two digits are 50 plus the exponent, and the last eight digits represent the original number. The decimal point is always assumed as being just before the first digit of the original number.

### Finding and Solving

We now know how numbers look inside a typical computer, how they get there and how they are stored. But just how does the control unit of the computer know what to do with these numbers? First of all, in the computer storage, we must have some way of identifying the location of all of the available numbers. Otherwise we cannot recover any particular number when we need it. The identification of the storage locations is made, as might be expected in a numerical machine, by the use of numbers (or "addresses").

The locations receive sequential numbers up to the capacity of the storage unit. Naturally if there are 4,000 locations available in storage, an address of 4050 is rather suspect. (In some machines these otherwise impossible addresses may occur with special meaning.) Normally, an address higher than the number of storage locations available would indicate an error.

The next step in solving problems on the computer is to identify just what operation the machine is to perform. A numerical instruction code is set up so that the computer itself sees nothing except a

number. Since this code is essentially arbitrary, it will vary from machine to machine. For example, in the IBM 650 the number "10" means "add" and the number "11" gives the instruction to subtract. In the Burroughs 205 computer "74" demands addition and "75" means "subtract."

Since both instructions and addresses are numbers, they may be stored directly in the computer storage. Hence the term "stored-program" computers. To make this concept clearer, let's take one widely used computer, the IBM 650, and analyze one of its instructions. A 650 instruction word looks like this:

+60 1532 0413

Note that this is a ten decimal-digit word just like the information numbers previously mentioned.

When the computer encounters this word, the sequence of events is as follows:

1. The first two digits contain the instruction code. In this case, "60" tells the machine to clear the numerical contents of the accumulator of the arithmetic unit to zero and then to add a specified number into it.

2. The next four digits, 1532, indicate the address of the specific number which is to be placed in the accumulator.

3. The last four digits, also an address (0413), tell the control unit that this location contains the number which is next to be interpreted as an instruction. The computer control then obtains the next instruction to be executed from the indicated location. This sequence repeats until completion of whatever operation is to be done.

### Programming the Digital

We now know how to write an individual instruction for a computer. The question next arises as how best to combine a series of instructions—i.e., write a program—to successfully solve your problem. It's possible to write down, number by number, the list of instructions which you want the computer to execute to solve the problem. To do this, a definite storage location must be assigned to every number needed in your computation.

To lighten the bookkeeping, an "assembly program" is written. The sole purpose of this set of instruc-

## Symbolic Program Eases Bookkeeping—Table II

Instruction	Address	Instruction Meaning
CLA	A	CLear the accumulator and Add contents of location A
FAD	B	Floating ADd to accumulator the contents of location B
FSB	C	Floating SuBtract from accumulator contents of location C
STO	X	STOre resulting number in location X

tions is to assume some of the detailed busy work of writing a program. One of the main functions of a computer is to do arithmetic, so it seems only sensible to let it do the bookkeeping involved in programming.

If we want to use a number such as 3.14159 in our program, why not call it "PI" and let the assembly program assign a proper storage location to the number? And if we want to add two numbers together, it is certainly easier to remember "ADD" than some arbitrary instruction number.

Let's assume that we want to compute the value of

$$X = A + B - C$$

Table II contains a symbolic program to compute X. Note that the symbol in the address column of the table stands for the location in the storage unit of the number which we want to use. We do not really care where "X" is located as long as we can get to it whenever we need to use it. We let the assembly program take this symbolic program and assign actual addresses. We write a symbolic program which the assembly program converts into what we really want—a real machine language running program.

The machine language program "written" by the assembly program does not differ from one we could have written ourselves. But in assigning absolute addresses, we would have manually gone through the same steps which the assembly program did, and probably have made more mistakes.

Although the assembly program is of help in preparing a problem for machine solution, there are still some major disadvantages. The main complaint is that we still must write one symbolic instruction for each machine instruction. In large programs this adds up to many thousands of individual steps.

In trying to find ways to avoid this one-to-one correspondence, the concept of the compiler was created. The compiler program accepts what the programmer writes, and then it generates, as output, the symbolic program for an assembly program. One statement input to a compiler may create ten to twenty symbolic instructions, which in turn create, one for one, ten to twenty machine language instructions.

A second disadvantage of the assembly program approach results from the marked similarity between symbolic and machine language. Essentially each computer requires a different symbolic language. The programmer, even though he does not write programs in specific machine language, still must be quite familiar with it.

However, since the compiler generates a symbolic program from the "source program" (i.e., what the programmer writes), we can take a source program and generate almost any symbolic program and consequently any machine language program. It is now possible to learn the one compiler language and without knowing any details about specific computers to write programs for them.

### It Talks to All

This suggests the concept of a universal computer language, a language for which compiler programs are available for a large number of different computers. The closest approach to this ideal universal language, in use in many installations today, is the system called Fortran (Formula Translation).

Initially developed by the International Business Machines Corp. for their Type 704 computer, Fortran has been extended to other IBM computers as well as to computers made by other companies.



Other compiler systems have been and are being developed today. However, Fortran appears to have received widest general acceptance so we will limit our discussion to this system.

Fortran is composed of two parts—Fortran language and the Fortran program. Fortran language, in which the source program is written by the programmer, is practically the same for any one of the many computers on which the program might eventually be run. However, there is a different Fortran program for each computer. Each Fortran program accepts the same source program, but each produces machine language programs for the particular type of computer for which it was written.

Since we are dealing with an actual language, there are certain rules of "grammar" which must be learned to correctly use this language. First, consider the problem of symbolic names for variables. Names may be one to six alphabetic or numeric characters with the first character indicating whether the number represented by the name is a fixed point or a floating point number. If the first character is *I, J, K, L, M* or *N*, then Fortran assumes that the variable is a fixed-point number and uses fixed-point arithmetic when using the variables

in computation. For example, if we want to call a series of problems by their job numbers, we might have a variable called *JOBNO*. Since the first character in the name is *J*, Fortran knows that the number it represents is fixed-point.

Floating-point variables may be given almost any name, as long as the first character does not indicate a fixed-point variable.

In Fortran, the rules of arithmetic are similar to algebra. If you wish to add two numbers, the symbol  $+$  is used and for subtracting you use the  $-$  symbol. The following is a valid Fortran expression:

$$X = A + B - C$$

The compiled program for this expression adds *A* and *B*, subtracts *C*, and saves the result, calling it *X*. As is true of symbolic programs, in this instance too we should remember that when we say "*A*," we really mean "the number that is currently occupying the location in memory which has been assigned to the symbolic name *A*." The equal sign means "store the result of computation in the symbolic location indicated by the variable on the left."

Because of possible confusion caused by representing the process of multiplication by *X*, the convention in Fortran is to use an asterisk

$*$  for this operation. Also, exponentiation is indicated by a double asterisk  $**$  rather than a superscript. Division is indicated by  $/$ , the shilling mark.

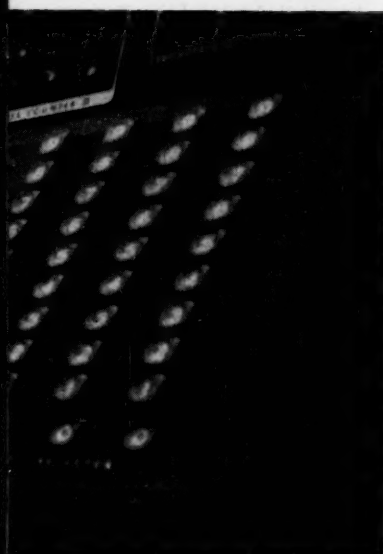
A typical simple problem which may be written for Fortran computation is the evaluation of the equilibrium vapor composition above a given liquid in a binary system. That is, we wish to evaluate the expression

$$y = \alpha x / [1 + (\alpha - 1)x]$$

where  $x$  is mole fraction of one component in liquid phase,  $y$  is mole fraction of one component in vapor phase and  $\alpha$  is relative volatility of the two components. Since our Fortran system cannot use the symbol  $\alpha$ , we use the symbol "ALPHA." In Fortran, our expression becomes

$$Y = \text{ALPHA} * X / (1.0 + (\text{ALPHA} - 1.0) * X)$$

We have introduced two additional features of the system: numerical constants and the use of parentheses. When it's necessary to use a "one," the number is simply written in; however, the decimal point is required since this indicates to Fortran that the constant is to be used as a floating-point number. All the compiler arithmetic is in floating point due to the variable names. The parentheses indicate exactly in what order the terms are grouped. Just



as in algebraic problems, the terms are always evaluated from the inside set of parentheses.

Now that we can program the arithmetic operations, the important question of how to use the input-output devices with Fortran must be answered. We will discuss only the use of card input and printer output, but use of tapes for input or output, for example, would be almost identical. There are three new statements which are required for input and output:

```
READ N, list
PRINT N, list
N FORMAT
```

The "read" statement list describes what variables are to be read, and the "print" statement list tells what variables are to be printed. The "format" statement describes how information we are reading and printing is distributed on the card or printed page. The number "N" pairs a format statement with an input or output statement.

The following is a Fortran program for our problem which can be compiled on any computer able to use the Fortran system.

```
READ 10, X, ALPHA
10 FORMAT (3F10.5)
Y = ALPHA * X /
  (1.0 + (ALPHA - 1.0) * X)
PRINT 10, X, ALPHA, Y
STOP
```

The first statement causes one card to be read according to format number 10. This format tells the program that there are three (3) fixed-point (F) number fields on the card, each ten digits long with five decimal places (10.5). The first two numbers punched on this card will be stored in the locations reserved for X and ALPHA. The next statement, describing the arithmetic operations, causes the value of Y corresponding to the values of X and ALPHA to be calculated. The print statement then causes the values of X, ALPHA, and Y to be printed with the same format as before.

A "stop" statement has been included to tell the computer when the computation is complete.

One powerful feature of the Fortran system for numerical computation is its ability to handle arrays of numbers. A set of numbers  $a_1, a_2, a_3, \dots$  may be represented in a Fortran program by the symbols  $A(1), A(2), A(3), \dots$ . These subscripts do not have to be fixed numbers but may be variable (only fixed-point variable though). Thus we might have  $A(I)$ . As the variable  $I$  takes on different values we obtain different elements of the A array.

This subscript nomenclature may be extended to two- and three-dimension arrays. For example, an application of a two-dimensional subscripted variable is the description of temperature distribution on a surface. We must specify two space coordinates to describe the position of a point on the surface; hence, in Fortran, we have  $TEMP(I, J)$ . Fixing values of variables  $I$  and  $J$  selects a particular entry in the temperature matrix.

### Applying Digital Computers

Digital computers are used in almost all fields of engineering, but they particularly have widespread use in chemical engineering. Since it would not be practical to discuss all possible applications, we will consider only three of them, one from each of three important areas. References found at the conclusion of this report present detailed methods of solution used for various problems.<sup>1, 2, 9, 10</sup>

Chemical reaction kinetics present a tremendous field for numerical computation. Generally, we are interested in maximizing yield

of a certain product which is involved in some sequence of reactions. This might be done by varying reaction temperatures, concentrations and other pertinent factors. However, before we can solve the maximization problem on a digital computer, we must determine a mathematical model of the system which will satisfactorily describe the effects of the variables.

If we have a reaction



we may write the ordinary differential equations which describe the rate of disappearance of the reactant or the rate of appearance of the product.

$$\frac{dC_A}{d\theta} = -kC_A$$

$$\frac{dC_B}{d\theta} = +kC_A$$

where  $C$  is concentration,  $\theta$  is time,  $k$  is the rate constant ( $k = ae^{-b/\theta}$ ) and  $a$  and  $b$  are constants characterizing the rate constant.

Corresponding differential equations may be written if more than one reaction occurs. If the system of reactions is very large, we then have a large number of differential equations that must be solved simultaneously in order to follow concentration profiles during the reaction.

However, we may not know all of the reactions involved. This means that we can follow one of two possible paths to attack the problem. On one we may assume that the reactions follow some plausible mechanisms and then try to determine constants which best represent the experimental data. If our set of mechanisms plus constants represent the data with sufficient accuracy, we then have our mathematical model. This model may be used in a computer—just as a physical process might be followed in a pilot plant—in experiments to determine an optimum set of reaction parameters.

The second approach is use of a statistical model. We can assume some polynomial-type dependence of yield on temperature, holdup time and other pertinent variables. Then, using statistical techniques, we can fit the polynomial form to the experimental data in order to obtain the mathematical model. For example, we may assume that

$$y = a_1 + a_2t + a_3t^2 + a_4c + a_5c^2 + a_6ct$$

where  $y$  is yield,  $t$  is temperature of reaction,  $c$  is concentration of reactant and  $a_i$  are statistically

determined regression coefficients which best make the equation represent the experimental data.

This model is used in the same manner as the model derived in the more theoretical fashion. Generally, it has been found that the statistical models are satisfactory for interpolating values, but the theoretically derived models are safer for extrapolation.

A need for two general types of programs is indicated in the above discussion: a program which will solve simultaneous differential equations by means of a numerical integration method; and a program for fitting statistical curves to arbitrary polynomial forms. Both problems arise so frequently that most computer installations have already programmed them in some general manner and have them ready to use.

Another excellent application of digital computers is in unit operations. In particular, distillation problems require the solutions of large sets of nonlinear simultaneous equations. There are currently a number of programs available to solve distillation problems which, before the advent of computers, were almost impossible to solve. The difficulty of obtaining solutions was not so much due to lack of theory but rather to the tremendous amount of computation required to solve the equations.

Linear programming has been used to determine the most economical mode of operation for a particular process. A typical application occurs in petroleum refineries where components must be blended into a variety of output streams. Generally input and output streams must satisfy restrictions such as, for example, how much of each component is available. The problem is to determine the operating practice which will yield maximum profit (or minimum cost, if that is the criterion) bearing in mind that all streams are subject to the restrictions and specifications.

### Buy or Rent

In general, digital computer manufacturers offer two possible methods of using their machines: rental or purchase.

Rental figures for computer installations vary from \$1,000/mo. to more than \$60,000/mo. A small,

relatively slow computer rents for approximately \$1,000-\$3,000/mo. A machine in this category will probably satisfy most of the computing requirements of a small group of technical personnel, or can even serve as a useful auxiliary aid in a large computer center.

The next step upward in size is the medium-size drum computers, at rents beginning at about \$3,700/mo. This figure represents the basic computer. It is possible to add magnetic tape drives, printers, etc., which might increase the price to over \$15,000/mo. A computer system in this price range probably satisfies the majority of all requirements which might be encountered.

The large computer systems begin, in price, at around \$20,000/mo. Again this rental price represents just the basic computer. Additional auxiliary units, enlarged memory and other such added features can push rent to over \$50,000/mo.

Purchase prices for the basic systems mentioned above are approximately \$50,000 for the small computer, \$150,000 for the medium and from \$750,000 up for the larger systems.

Maintenance is provided by the manufacturer for a rented machine, but when the computer is purchased, the purchaser provides maintenance. It is possible, however, to obtain an agreement whereby the manufacturer will service purchased equipment. These machines are sufficiently complex so that expert maintenance is one of the important aspects of a successful computer installation.

As part of the service furnished with most computers, manufacturers provide courses and manuals to train a group of programmers for the installation. When a company has its own group of experienced computer personnel, it can provide further introductory and training courses for additional personnel.

The total number of persons in a computer group varies with the type of service which the particular group performs. Some companies maintain a large group which does all the work with the computer. People who wish to have problems solved on the computer submit the problem and await the answer. This, of course, means that no one outside of the computer group has to really understand the detailed operations of the machine. This

has been called "closed shop" operation.

On the other hand, it is feasible to train many people in the company to use the computer so that if they have a problem they may do their own programming. The computer group in this "open shop" arrangement then serves more for technical assistance and to work on problems which are too complex for the nonspecialist. Both extremes, as well as compromises of the two, are used.

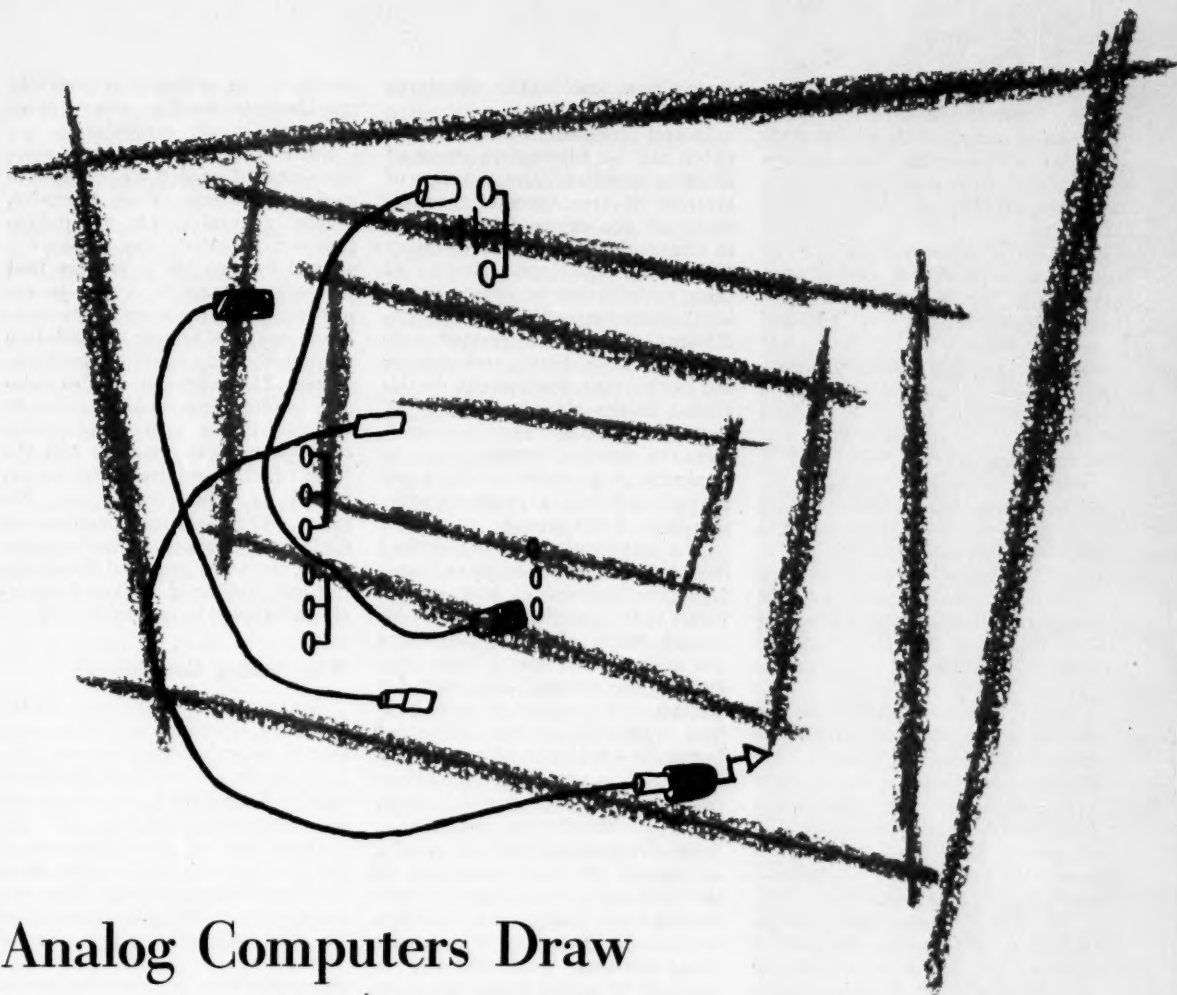
Computer users have found that various programs may be used in many different problems in various computer installations. For example, a program to solve simultaneous linear algebraic equations is extremely useful to many different computer groups. Organizations exist, comprising users of a particular type of computer, that exchange existing programs among member groups. They include, among others, "USE" (Univac Scientific Exchange) for those who use the Remington Rand Univac computer and "TUG" (Transac User's Group) for those using the Transac computer made by Philco.

Detailed descriptions of any computer, including coding manuals, are generally available directly from the manufacturer of a computer. Most companies have prepared brochures describing applications on their computers as illustrations of what can be solved and how quickly it can be done.

### Summing It Up

Both digital hardware and programming techniques continue to develop. The newer computers have faster operating speed, but cost per arithmetic step is actually decreasing. Availability of the compiler-type program makes it possible for anyone—with just a small amount of training—to code his own problems for computer solution. Compilers also make it possible for computer group personnel to spend more time in problem analysis and less time with the mechanical busy work of coding a problem.

Computer program exchange groups are an additional development which is becoming increasingly more valuable. These groups are formed to save member companies the duplication of time and effort in programming identical problems.



## Analog Computers Draw Answers to Questions

In process control dynamics.

In chemical pilot plant study.

In unit processes and operations.

PAUL E. PARISOT, Monsanto Chemical Co., St. Louis, Mo.

**I**N DEFINING and describing analog computation, perhaps we should consider the modifying adjective, analog, more meaningful than the noun, computation. Frequent use of analogies is made in all fields of human endeavor to translate the meaning of some subject not understood into terms of a subject that is better understood.

By proper use, analogies are in-

deed powerful tools in the methodology of learning. We are here concerned with a specific application of analog translation—the electrical analog of a physical process which has more or less successfully eluded analysis by other efforts.

The general-purpose analog computer, the computer that we will discuss, is an electronic device which regulates voltages at various

points in its electrical circuitry. When the circuitry represents a physical process, the voltage regulation simulates the fashion in which that physical process regulates its dependent variables. Similarity of behavior of the analog computer voltages and the physical process variables is the analogy.

Savings in time, money and manpower from study of behavior of

voltages of the electronic computer rather than variables of the actual physical process justify analog studies. We will examine later the requirements to realize such savings and to establish a proper analog facility.

The general-purpose analog computer is not a *direct analog* of a process in the sense of one-to-one correspondence of the physical process elements to their electronic counterparts. For example, a computer resistor does not represent a pipe exhibiting resistance to fluid flow, nor does an inductance coil represent an inertial field.

Such direct analog computers do exist (e.g., network analyzers), but they are not considered here. The general purpose computer is an *indirect analog*. The computer voltage variables change magnitudes in "computer time" in correspondence with magnitude changes of the dependent variables of the physical process.

An important component of the electronic analog computer—the operational amplifier—has made the indirect analog possible. The contribution of the operational amplifier is greater precision, ease of operation and flexibility for constructing many physical process analogs on a single machine.

The size of analog computer installations is commonly measured in terms of the number of operational amplifiers in the installation. Large installations, of from 100 to 1,000 amplifiers, are found in the aircraft and missile industry. This industry pioneered use of analog computing equipment for simulation of the behavior of missile and aircraft systems and their components.

### Use Analogs in Processing

For what use can the analog computer be applied in chemical technology? In general, a chemical or chemical engineering problem that can be expressed mathematically in terms of a combination of algebraic and ordinary differential equations presents a potential application.

Three major areas in which such problems occur are unit processes, unit operations and process control. The solution of transients for problems in these three areas has become increasingly important as greater demands in performance of chemical processing are made by rising manufacturing costs, keen

competition and higher standards of quality control.<sup>12</sup>

In unit processes, the analog computer can be adapted to study of reaction kinetics. The kinetics of systems of simultaneous chemical reactions are expressible in terms of simultaneous nonlinear ordinary differential equations. Kinetics of these systems can be analog-simulated even for nonisothermal conditions. Effects of reactor configuration for batch, tubular or stirred reactor designs can be included in the studies. Purpose of these analog studies may be to optimize the primary product yield, to minimize an undesirable side product or to obtain a general understanding of the system.

The transients occurring in fluid flow, heat transfer and mass transfer operations are of frequent interest to the chemical engineer. Although many of these operations are designed for steady-state conditions, the process may vary far enough and frequently enough so that transients become important factors in prediction of process behavior. It is not always obvious *a priori* that design for or operation at the steady state is desirable.

An interesting facet of analog simulation of unit operations is the ease of testing effects of exceeding "safe" operating bounds in the process. Behavior of processes under runaway conditions can be explored by analog simulation quite successfully without risk of loss of valuable experimental equipment.

Investigations also may be carried out for situations that defy present state of the art. For example, analog exploration might determine the process benefit of a successful research program to develop a better separator for a recycle stream. Although the qualitative answer may be known, the quantitative answer may only otherwise be available by detailed computation.

Much has been written about the application of analog computation to process control theory and design of control systems.<sup>3,7,11</sup> It is perhaps here that the use of analog computers in the chemical processing industries has been most stressed. Because of the identification of control systems with transient process behavior, and the fact that the analog computer is most useful in computation of transient

solutions, the analog is erroneously considered by many as solely a process-control study computer.

Such is not the case, but since the scope of analog application to control problems is so extensive, several general points of application will be cited. For devising a control system for a process that is nonlinear and is known to experience transients well into nonlinear regions, analog computation may be the only available problem-solver. The computer is also valuable in obtaining rapid solutions to complex linear control problems, even when these solutions and the form of these solutions can be obtained by other techniques. Finally, by generating hypothetical control problems on an analog computer, data are provided for devising and testing of advanced analysis techniques in control theory.

### Why Analog Computers?

Granted that solutions of the problems cited are desirable, why should we try analog solutions? Before we can answer that, it's necessary to delve a bit further into analog computer operation.

Operation of the computer is similar to operation of a pilot plant or bench-scale apparatus. The analog computer has often been called an electronic pilot plant. Analog voltage variables bear one-to-one correspondence to process variables. (Remember that computer components do not bear this one-to-one correspondence.) Changing appropriate voltages in the computer and noting the behavior of other computer voltages might, for example, correspond to changing a flow or inlet temperature in the process to study its effect on the rest of the process.

In such applications, the analog computer is no more regarded as a device to solve mathematical equations than is a pilot plant. It's an advantage of analog computation that the operator retains the "feel" of the actual process.

To establish a proper analog model of a process, the model is tested against experimental data. These data may include the non-tabulated experience of process technologists. It's pertinent to digress to stress that the analog does not replace the bench-scale apparatus or pilot plant, but rather amplifies the power of such experi-

mental tools. The dynamic results of both the experiment and the analog computation are easily interchanged.

Controlled variables or parameters for the process problem are usually placed in the analog circuit as potentiometer settings. These potentiometers (variable resistors similar to the volume control of your TV set) are easily reset. The operator can readily change parameter values without rewiring the computer circuit for the problem. This ease of pot twisting is a particular advantage when the only suitable method of analysis is by trial-and-error.

Now that we've pointed out some advantages for the analog approach, let's examine two major disadvantages. The first is that the analog can solve only ordinary differential equations. Partial differential equations cannot be solved unless they first can be reduced to ordinary differential equations.

The second disadvantage is that computer capacity—in terms of numbers of computer components—and complexity of problems that can be handled is closely related. The analog operates under essentially fixed problem time for all problem complexities. An analog computer is therefore capacity-limited, rather than time-limited, in its application to engineering problems.

### Components Complete Circuit

In the solution of the types of problems we're discussing—namely those that are stated in terms of differential and algebraic equations—several basic mathematical operations are required of the computer. They include algebraic summation, sign inversion, integration, multiplication (and the inverse operation, division) and generation of arbitrary or nonanalytic functions. In addition to these mathematical operations, the computer also must perform on command of the operator and display results of its operations on the analog model circuit, i.e., present the solution to the problem on a meter or recorder.

First let's consider the computer components which perform the mathematical operations. Later we'll examine some peripheral equipment. As mentioned before, the operational amplifier is of pri-

mary importance to analog computers for it performs three operations—summation, inversion and integration.

The operational amplifier is a high-gain (of the order  $10^6$  to  $10^8$ ) d.c. amplifier that uses negative feedback. Detailed explanation of the electronic circuitry to provide the capability of performing integration and summation will not be given here but can be found elsewhere.<sup>6</sup> From changes in type and size of feedback element—a change which is simple to make on most computers—the amplifier derives its performance as summer or integrator.

When the feedback element is a resistance, the amplifier algebraically sums two or more input voltages and provides the result (with opposite sign) as an output voltage. This summation occurs continuously throughout the problem-solving period.

When the feedback element is a capacitor, the amplifier performs integration of an input voltage with respect to the dummy variable, machine time, and provides the negative definite integral as an output voltage.

Since an independent variable, such as real time or a spacial coordinate, is easily related to the machine time dummy variable, we can speak of performance of integration with respect to the problem independent variable. The amplifier imposes an initial condition on the integral so that it is a definite integral which appears at the output. Integration is performed simultaneously and continuously with the solution of the other equations throughout the period of the problem solution.

The amplifier output voltage is always of opposite sign from its input voltage. It inverts the sign of input voltage for both summation and integration amplifiers.

Multiplication can be performed by several of the computer components. By changing input resistance of an amplifier, a sum or integral can be multiplied by integral numbers. Like feedback impedance (resistance or capacitance) the input impedance can be internally provided in the amplifier. You have only to apply the input voltage to the proper amplifier input terminal to obtain this multiplication. Such magnification of an input voltage by a constant value is called *problem*



gain, but it should not be confused with amplifier electronic gain.

Multiplication of a variable by a fraction occurs when a voltage variable is applied to a potentiometer. The potentiometer, which is basically a voltage divider, can be set to any value from zero to unity. It is a potentiometer connected to  $\pm 100$  v. that imposes the initial condition on an integrating amplifier.

The product of two variables results from either a servomultiplier or an electronic multiplier. The servomultiplier is a servo-mechanical system of potentiometers. It automatically positions one or more identical potentiometers in proportion to input voltage to the servomechanism. If  $x$  is input voltage to the servomechanism, a voltage  $y$  applied to the input of one of the potentiometers produces a voltage  $kxy$  as the output.

The proportionality constant  $k$  is usually 1/100 so that a product  $xy/100$  is obtained. Notice that the two variables at a value of 100 v. will give a product of 100 v. This is convenient, because 100 v. is a maximum voltage that should appear at any point in an analog computer circuit.

You can obtain as many products  $xy_1, xy_2, xy_3, \dots$  as there are potentiometers mechanically coupled to the servomechanism. The inverse operation, division, is also performed by these multipliers in conjunction with a high-gain amplifier (an amplifier with no feedback element).

The servomultiplier can be made nearly as accurate as a d.c. amplifier, its accuracy being limited only by potentiometer linearity. However, its frequency response is quite poor in relation to the frequency response of other computer components. It is often the limiting factor in solution time of a problem.

Because electronic multipliers are relatively independent of moving mechanical parts, they offer much better response than do servomultipliers. On the other hand, their accuracy may not always be as great as the servomultipliers.

### Components Do Special Jobs

Function generators provide non-analytical functions which cannot be generated by the components we've discussed. A device fre-

quently used as a function generator is the "pot padder." The pot padder is used with the servomultiplier. The potentiometers of the servomultiplier have a series of taps, usually from 10 to 20, at fixed positions along the resistance wire of the potentiometer. By means of the pot padder, voltage proportional to  $f(x = x_i)$  is applied to the tap which corresponds to the position which the potentiometer assumes if  $x = x_i$  is the input voltage to the servomechanism. The resulting output is a straight-line segment approximation of  $f(x)$ .

The diode function generator also provides a straight-line approximation of a function. It is more versatile than the pot padder because increments of the straight-line segments for  $x$  can be varied; for pot padders, the increments of  $x$  are fixed. Fixed or preset diode function generators are available for commonly used analytic functions such as logarithmic, square root and trigonometric functions.

Relays and diode limiters are used for representation of such nonlinearities as backlash, saturation and other discontinuous phenomena.

Two types of recorders, the variplotter and the six-channel brush recorder, plot the results of an analog solution. The variplotter, or  $x$ - $y$  recorder, is a servo device used for high-accuracy plotting of one variable against another. Scale of plotted variables is easily changed. The six-channel brush recorder records six variables simultaneously as a function of time. Both recorded variable scale and chart speed can be changed.

For high-speed or repetitive-type computing, an oscilloscope presentation is sometimes useful in control studies or preliminary studies of the effect of parameter changes on the problem solution.

An accurate (usually digital) voltmeter helps set potentiometers and verify programs by checking outputs of the various components. The digital voltmeter can be either electronic or servomechanical. Digital print-out devices are also available.

Voltages of each of the separate computer components terminate at a central computer location. Depending on size and type of computer, these terminals are properly connected for a particular problem either directly or by a wired patch

panel. The patch panel has the advantage that problems can be prewired. It is necessary only to change patch panels to change the problem on the computer.

A central control system starts and stops computation as necessary. Relays provide this control. Typical control commands are *operate*, *reset*, *hold* and *pot set*. Command *operate* starts the computation, *hold* interrupts computation and *reset* returns the problem solution to the initial conditions. *Pot set* is used when setting potentiometer values.

### Programming the Analog

One advantage of analog computation is ease of programming a problem. Programming consists of the following sequence: arrangement of problem equations, magnitude scaling, time scaling, preparation of wiring diagram and wiring of patch panel or computer.

All equations are arranged with one term or variable on the left hand side and all other terms on the right hand side. If the equation is a differential equation, the highest order derivative appears on the left side. For example,

$$d^2x/dt^2 = a_1 dx/dt + a_2 xy + a_3 x + a_4 f(y) \quad (1)$$

$$y = k_1 x + K \quad (2)$$

We pointed out before that a true advantage of analog computation for the technologist who is not a computer specialist is that the "feel" of the process is retained. Along with this advantage there is a responsibility. It is important that the technologist who uses an analog computer to solve his problems always keep in mind the physical phenomena occurring—that he think realistically, quantitatively.

Since all dependent variables of the process are represented by voltages (machine variables) in the computer and maximum computer voltage is  $\pm 100$  v., all dependent variables must be magnitude scaled. Magnitude scaling requires an estimate of maximum value of the dependent variable being scaled. This maximum value is represented by 100 v. machine variable.

If, for example,  $y$  is a concentration in moles/l. with maximum value of 0.15, then  $y_{max}$  (the machine variable) = 100 v. when  $y_{max} = 0.15$  moles/l. Stated algebraically,

$$y = 0.15 \bar{y} / 100 = A_y \bar{y} \quad (3)$$

The value  $0.15/100 = A_t$  is the scale factor and in this case has units of (moles)  $(l.)^{-1} (v.)^{-1}$ . It's usually convenient to choose integer or integral fraction values for the scale factor. For the above example, the scale factor could be  $2/1,000$ .

Having estimated the maximum values of all dependent variables and chosen appropriate scale factors, the resulting set of algebraic equations that defines problem variables in terms of machine variables are substituted in the problem equations.

Equations must also often be time scaled. The analog computer performs all of its operations including that of integration in terms of the independent variable machine time, units of which are usually seconds. Mathematically, machine time may be considered a dummy variable related to the process independent variable (whether real time or space coordinate or other) by another algebraic or differential equation.

The maximum value of machine time  $\theta$  is directly related to stability characteristics of the computer, particularly of the integrating amplifiers. For many computers, a choice of  $\theta = 100$  sec. may be suitable, for 100 sec. is well below maximum computation time limit of the computer and is not too short to exceed response of the components. With this time factor the problem solution requires 100 sec. of machine time to complete.

Time scaling can be applied in the same fashion as magnitude scaling. For example, consider the real independent variable  $t$  as real time with maximum value of 10 hr. Then

$$t = 10\theta/100 = A_t\theta \quad (4)$$

where  $A_t$  is the time scale factor and has units of hours/machine second. Substitution of this algebraic equation into the problem equation completes the time scaling of the problem. The form of Eq. (4) provides an auxiliary equation that may be employed in computation to give the reference independent variable.

Two notes of caution in time scaling: all rates and acceleration parameters should be in units of the real independent variable. And remember that for derivatives, the appropriate substitution is  $dt = A_t d\theta$ ,  $dt^2 = A_t^2 d\theta^2$ ,  $dt^3 = A_t^3 d\theta^3$ , etc.

The time- and magnitude-scaled

equations are a set of instructions for connecting the analog components. A wiring diagram, using standard component symbols such as those in Fig. 1, guides connection of the analog circuit.

An example explains preparation of the wiring diagram. Assume that Eq. (1) and (2) have been appropriately time- and magnitude-scaled, that the parameters represent combinations of the original parameters and scale factors, and that variables  $\bar{x}$ ,  $\bar{y}$  and  $t$  represent machine variables  $x$ ,  $y$  and  $\theta$ .

Assume also that the term  $d^2x/dt^2$  is available as a voltage. The terms  $dx/dt$  and  $x$  can be obtained if this voltage is integrated twice (Fig. 2a). These latter two terms are available for feedback to form the second derivative. In addition the terms  $xy$  and  $f(y)$  would be available from a multiplier and a function generator. Now the diagram looks like Fig. 2b which illustrates formation of the previously assumed available second derivative.

We're not implying here that terms for the second derivative could not have been summed directly upon the first integrator rather than using a summer. In fact, summing is usually done on

integrators to conserve computing equipment.

Note that the coefficients  $a_i$  are formed by combination of pot settings and input gain on the summer forming  $d^2x/dt^2$ . The factor  $1/100$  from multiplication of  $x$  and  $y$  must also be taken into account in setting potentiometer 3. Finally,  $y$  is formed on a summer using voltages developed from other components (Fig. 2c).

After some experience, it's possible to optimize the program in terms of using a minimum number of components. A more detailed treatment of programming procedures will be found among the references.<sup>5, 6, 10</sup> Last step of the programming procedure is to wire the patch panel or computer panel using the wiring diagram as a guide, and check the wiring for errors.

### Try Programming Reactions

The following example illustrates the programming technique. Although the problem is simple in size, we hope it's apparent that a considerably more complex problem could be handled almost as easily if computer capacity is available.

The following chemical equa-

### Component Symbols Are Standard for Operations

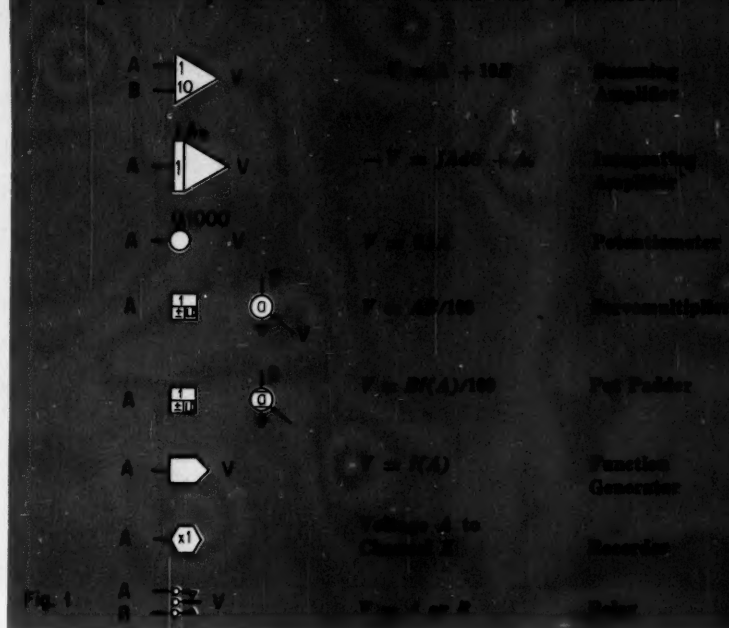


Fig. 1

### Example Problem Leads to This Wiring Diagram

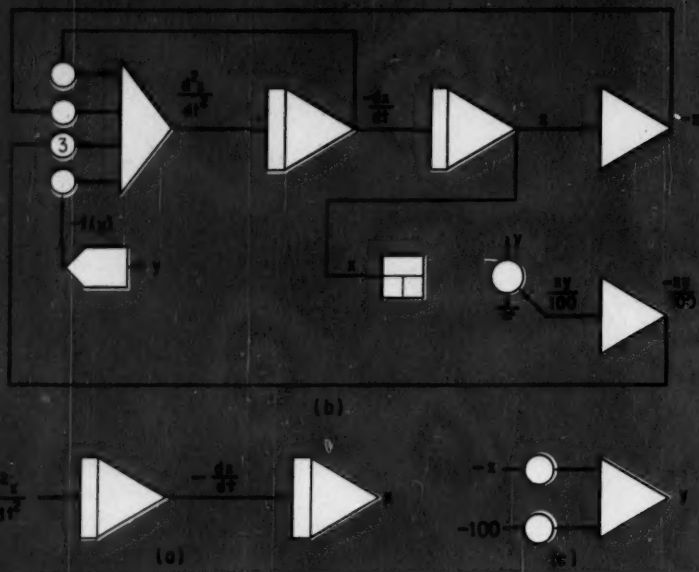


Fig. 2

### Simulate Kinetics Problems With Equations—Table III

#### Differential Equations

$$\begin{aligned} dA/dt &= -k_1AB \\ dB/dt &= -k_1AB - k_2BC \\ dC/dt &= 2k_1AB - k_2BC \\ dD/dt &= 2k_2BC - k_3D \\ dE/dt &= k_3D \end{aligned}$$

#### Magnitude and Time Scaling Equations

$$\begin{aligned} A &= \bar{A}/100 & D &= \bar{D}/50 \\ B &= \bar{B}/100 & E &= \bar{E}/50 \\ C &= \bar{C}/50 & t &= (0.5/100)\theta \end{aligned}$$

#### Machine Equations

$$\begin{aligned} dA/d\theta &= -0.005k_1AB/100 \\ dB/d\theta &= -0.005k_1AB/100 - 0.01k_2BC/100 \\ dC/d\theta &= 0.005k_1AB/100 - 0.005k_2BC/100 \\ dD/d\theta &= 0.01k_2BC/100 - 0.005k_3D \\ dE/d\theta &= 0.005k_3D \end{aligned}$$

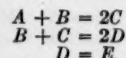
#### Potentiometer Settings

Pot 1*	0.5000	6†	0.1200	11	0.1200
2	0.5000	7	0.1200	12	0.0300
3	0.0000	8	0.1200	13	0.0300
4	0.0000	9	0.1200	14	0.0100
5	0.0000	10	0.0600		

\*  $A_0 = 0.5$  mole/l.  $A = 50$  volts

† Setting =  $0.05k_1/\text{Input gain} = 0.005 \times 24/1$

tions comprise a system whose reactions we wish to follow by analog simulation:



where the reaction constants for the three reactions are, respectively,  $k_1 = 24$  l./mole min.,  $k_2 = 12$  l./mole min., and  $k_3 = 6$  min.<sup>-1</sup>. Assume the maximum concentration in a one-liter batch reactor of components A and B is 1 mole/l. Differential equations for the system are listed in Table III.

Choose as maximum values for A and B, 1 mole/l., and for C, D and E, 2 moles/l., and the magnitude scaling equations of Table III may be derived. Make an estimate of a reasonable time for 90% of the reaction to be complete. This estimate, for time scaling, need only be crude, so choose 0.5 min.; i.e. we desire to stretch out 0.5 min. of real time into 100 sec. machine time so as not to exceed machine limitations.

Machine equations result from direct substitution of magnitude and time scaling equations into the original differential equations. (Note that bar notation is dropped in the machine equations of Table III.) Coefficients of terms of the machine equations are used to calculate potentiometer settings and problem gains.

Fig. 3 is the wiring diagram for the problem. Results of computation are presented on a variplotter as in Fig. 4. In this problem, the experimental study has been slowed down for observation. In other problems, such as pilot plant simulation, the experiment might be speeded up from hours or days of real time to seconds of machine time.

### Installing Analog Computers

Size of an analog computer installation may range from ten to over a thousand amplifiers—the cost from one thousand to several million dollars. We pointed out that the complexity of the problem you can solve on the analog is a direct function of its capacity. Thorough planning is required to choose the right number and type of components to do the required job. Poor planning may be costly; it may result in inability of the computer to accomplish its intended task.

The following steps are impor-

tant as planning guides for an analog installation:

1. Program a number of your problems for which the computer may be intended.

2. Using these programs as a guide, rough out the distribution of components required. Except for the smallest of computers, distribution of linear and nonlinear elements should not change a great deal with the growth of a particular installation.

3. Unless the computer is to be used as a training device and applied only to comparatively simple problems, adequate provision for expansion should be established. A major investment in analog equipment can be built up economically in increments. For example, initially it may be wiser to sacrifice size for performance if it is anticipated that future requirements may demand both high performance as well as increase in size.

4. Plan for as much computer flexibility in problem scheduling as can be obtained if the installation is of any major size.

A considerable range in the cost per computer of a nominal size exists. This is particularly true for computers having more than 30-40 amplifiers since much of the cost stems from function generators, multipliers, recorders and other auxiliary equipment. Cost per amplifier ranges from several hundred dollars for the smallest size computers to over a thousand dollars for the largest size. Some major manufacturers of analog computers are listed in Table IV.

Size and makeup of computer staff personnel are dependent on computer size and applications. At least one member of the staff should understand in detail the electronics of the computer. This requirement

#### Recorder Presents Results

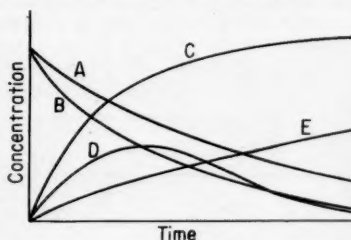


Fig. 4

is not stipulated because of maintenance but because frequently questions arise referring to limitations which the electronics impose upon the computer operation. For others of the group, a "black-box" knowledge of computer components may be adequate.

Since programming for the computer is not difficult, a short period of on-the-job training, preceded by several days of formal indoctrination, will suffice for computer personnel. This period might vary from several days or weeks for smaller computers to several months for larger installations.

A good technical background in the area of the problem types to be encountered is a paramount requirement of computer personnel. Construction of the analog model demands a good grasp of fundamental and theoretical concepts of chemical and engineering technology.

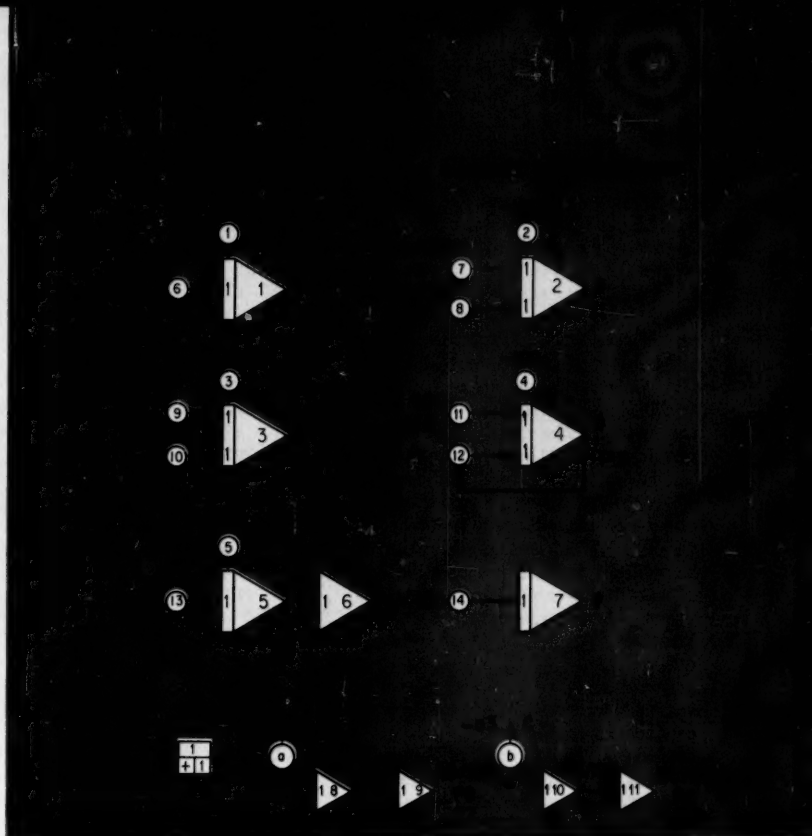
If the computer installation is large and the problems varied, a considerable portion of this knowledge must come from scientists and engineers in the company who are not members of the computer group. Monsanto has a policy of giving a one-week analog computer

indoctrination course several times a year. Its purpose is to acquaint company personnel with the use and operation of the analog computer and to establish analog group communications with the wealth of technological knowledge these people have.

One of the administrative problems for a large facility is allocation of computer time. One particular limitation is that of changing from one analog problem to another. It arises both from expense of keeping an extensive file of problem programs wired on patch panels and from the time required to manually set potentiometers. The latter factor is being eliminated by introduction of servo-set potentiometers for large computers. This should

#### Analog Computer Makers—Table IV

Beckman Instruments, Inc.  
Computer Systems, Inc.  
Donner Scientific Co.  
Electronic Associates, Inc.  
Goodyear Aircraft Corp.  
Heath Co.  
Geo. G. Philbrick Researches, Inc.  
Reeves Instrument Corp.  
Southwestern Industrial Electronics



decrease pot set time by at least an order of magnitude.

Computer problems come from within and outside the analog group. How should priority of problems be established? How should costs be distributed? The answer to priority is dependent on structure and procedures of individual organization. If cost is not met by charge to the specific problem-submitting organization but is distributed uniformly among all potential users, a greater emphasis is placed upon priority decisions. Such cost distribution is less likely to discourage submittal of worthwhile problems by potential users. However, operation cost allocation is subject to specific requirements.

Some analog computer manufacturers have established computation centers at important industrial locations in the country. It is possible to rent time on large computers at these facilities. Furthermore, computer staffs at these centers are available for technical assistance in programming, patching and running problems. Occasional short courses are run by the manufacturers to acquaint user company personnel with the analog.

Maintenance of analog computing equipment is similar to that of other electronic equipment that a chemical company is likely to have. Daily, weekly or monthly performance checks are made on the computer components, in addition to the usual preventive and remedial maintenance.

### Summing It Up

There are six points that might well be preserved from this discussion.

1. The analog computer has, as its most important use, the application to transient problems that occur in unit processes, unit operations and process control.
2. The analog computer simulates a physical process by operating on machine voltages in a

fashion similar to that in which the physical process operates on its dependent variables.

3. The process "feel" is preserved in analog computation.

4. Simplicity of programming makes the analog readily accessible as a computing tool to the average technologist.

5. Limitations on size or complexity of problems that an analog computer can solve are directly related to computer capacity, i.e., number of components. Speed or time of solution is relatively independent of problem size or complexity but is dependent on component response.

6. The analog computer possesses the high-speed computing characteristics general to modern computer when it is properly applied to the solution of simultaneous ordinary differential equations.

(In addition to the analog computer manufacturers listed in Table IV, p. 143, we should like to thank the following digital computer manufacturers for cooperation in developing the CPI Computer Census: Bendix, Burroughs, Day-

strom Systems, International Business Machines, Royal-McBee, Thompson-Ramo-Wooldridge Products, Univac Remington-Rand, Westinghouse. Photographs courtesy of Electronic Associates, Inc., and International Business Machines Corp.)

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WILLIAM E. BALL

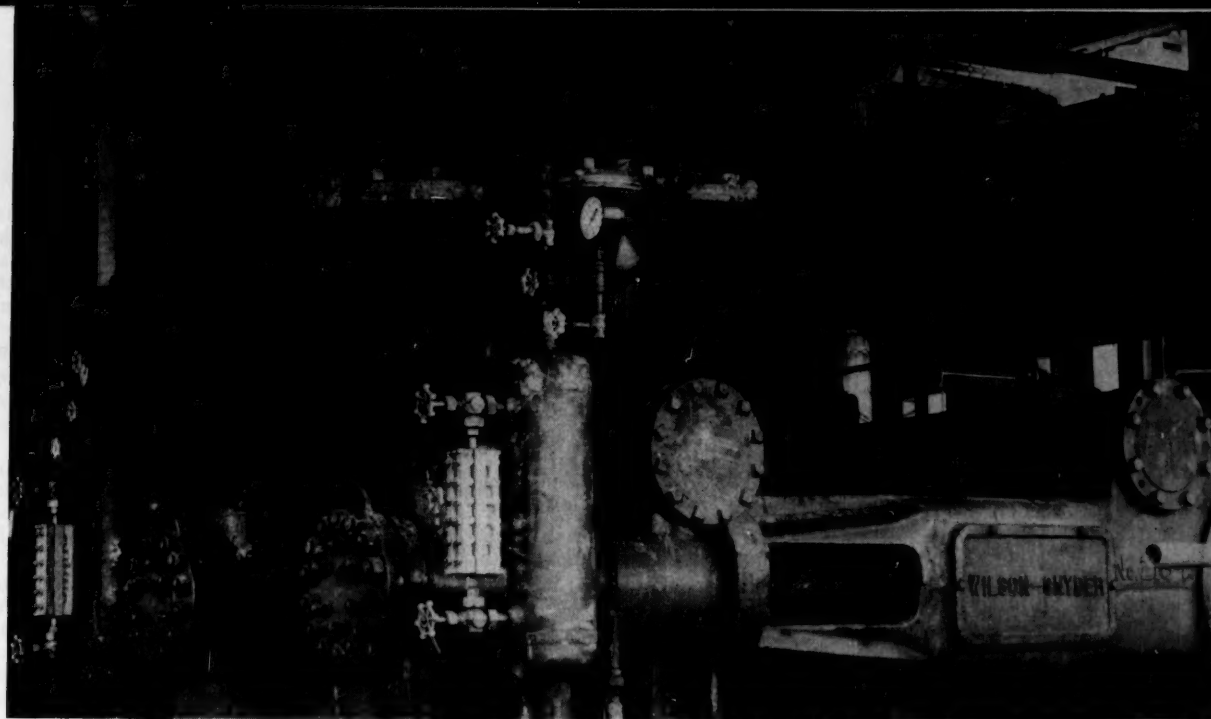
Holder of a B.S.Ch.E. and D.Sc.Ch.E. from Washington University, St. Louis, Ball has experience in chemical engineering and computers. While pursuing graduate studies, he taught at Washington U. and was an applied science representative for IBM. Ball, who co-authored the popular *CE Math Refresher*, joined Monsanto's research and engineering division digital computer staff in '58. He's a member of AIChE and ACM.



PAUL E. PARISOT

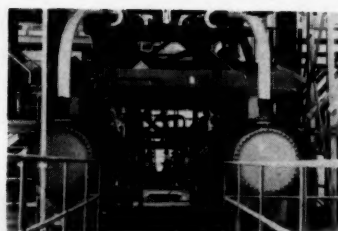
With a B.S.Ch.E. from the University of Illinois and M.A.Ch.E. from Princeton, Parisot is now working on requirements for his Ph.D. from the chemical engineering department at Princeton. Before joining Monsanto's research and engineering division, he was assistant professor of chemical engineering at USAF Institute of Technology. He is now group leader, analog computer installation, at Monsanto.

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SLURRY PUMPS in Cuba are one of the keys to the success of this new nickel-extraction process.

## Chemical Engineering Know-How Puts . . . New Nickel Process On Stream



HEAT EXCHANGERS in the leaching system help the economics.

BACK at the turn of the century, groups of engineers roamed the north coast of Cuba in quest of a red clay called iron laterite. In the hills of Oriente Province, deposits of this clay lie right on the surface.

At that time, these deposits were considered valuable only for their iron content. Unfortunately, the presence of accessory metals, such as nickel, chromium and



LEACHING VESSELS, using steam for agitation and  $H_2SO_4$  as the leaching agent, are the heart of the system.

cobalt proved a fatal drawback—steels made from these natural clays were too brittle.

Today, this same red clay is beginning to flow through the reactors, thickeners, pumps and pipes of two new plants—not for its once-sought iron, but to extract the metals of today's technology: cobalt and nickel.

Paramount to the overcoming of 50-year-old obstacles is the astute engineering that went into the leaching system. With nickel-bearing ore low in magnesium, an economical acid leach, instead of an alkali leach, is possible. Selecting and designing the pumps, heat exchangers and vessels for the leaching system are the keys to its success.

To get at the roots of this landmark in chemical engineering, we have to turn back the calendar 20 years.

#### JAMES A. LEE, Southwestern Editor

**I**N THE late 1930's, the Freeport Sulphur Co. acquired mineral holdings in the Oriente area of north Cuba with the idea of taking a new look at the ores. Instead of using the ores directly for steel-making, which has proved unsuccessful, Freeport investigated the production of the accessory metals—cobalt and nickel.

Holdings were obtained in Cuba at Nicaro and Moa Bay. Basically, the mineral found there is an iron ore with a nickel content at Moa Bay, for example, averaging 1.36%.

Metallurgical development started in 1939, and a small pilot plant was under way in Texas three or four months before Pearl Harbor. Then,

war came; and with it, the big demand for nickel.

Freeport designed and built the Nicaro plant for the U.S. Government. Ground was broken in July 1942 and the plant completed in December 1943.

It was operated by Freeport for the government until shutdown in 1947. With the Korean conflict on the scene, the plant was reactivated, but now run by the Nickel Processing Corp.

Today, this firm operates the plant for the U.S. Government. Ore is sold to the U.S. Government, for use in the Nicaro plant, by the Nicaro Nickel Co., a wholly owned subsidiary of Freeport Sulphur Co.

#### Moa Bay Potential

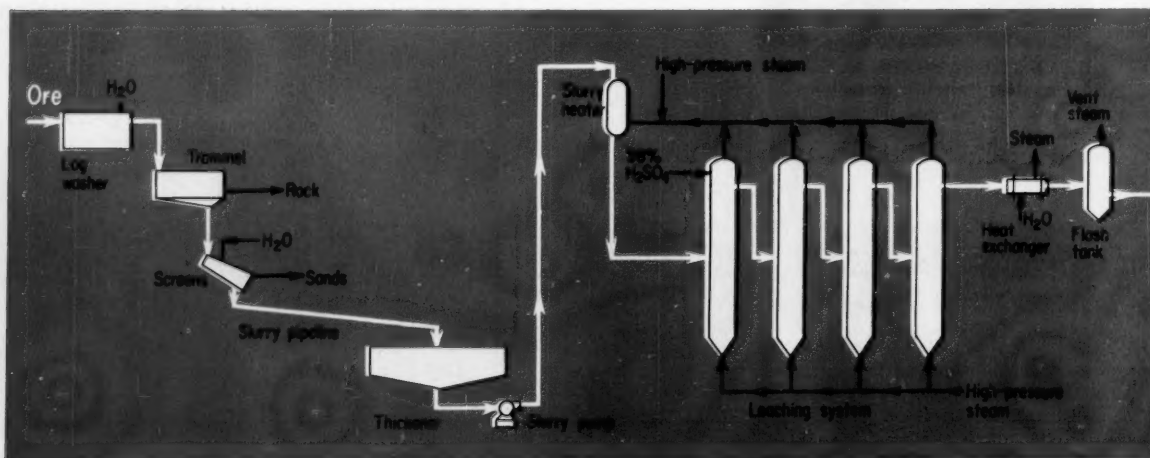
After 1950, it was decided to take another look at the picture on Moa Bay. The look proved well worthwhile. Ore at Moa Bay isn't identical with that at Nicaro, where a high magnesium content virtually dictates the process. At Moa Bay, the ore is low in magnesium, high in iron, and contains about twice the cobalt of Nicaro ore.

Low magnesium content means an acid leach is possible. This has certain economic advantages over the  $\text{NH}_3$  system used at Nicaro, and  $\text{H}_2\text{SO}_4$  is the obvious choice.

Investigation of the process began in August 1952 at Freeport's Hoskins Mound, Tex., research laboratory in bench-scale autoclaves. Next step in the research program began in July 1953 and was carried out in a larger tubular autoclave designed to simulate conditions contemplated for commercial operation.

Meanwhile, during the latter part of 1952, Freeport learned that Chemical Construction Corp. (Chemico) was carrying on development work that in part paralleled Freeport's work. In February 1953 Freeport entered into an agreement with Chemico giving Freeport exclusive rights to the use of the Chemico technique for the treatment in the U. S. and Cuba of Cuban lateritic ores primarily valuable for their nickel and cobalt content.\*

\*Chemico subsequently assigned this agreement to American Cyanamid Co. which then assigned it to Sherritt Gordon Mines, Ltd.



Research was carried out at Freeport's expense, as provided in the agreement, from June 1953 until January 1955 in Chemico's laboratory at Linden, N. J. to further develop the technique and adapt it to the final separation and production of nickel and cobalt from Moa Bay ores.

### Pilot Plant Points the Way

In addition, during the latter part of 1953 Freeport built a 10-ton/day pilot plant at Hoskins Mound comprising the process steps involved to produce a concentrate from the raw ore. This part of the process included an  $H_2SO_4$  leaching process that Freeport developed.

Tests were conducted at Hoskins Mound on 300 tons of Moa Bay ore, carefully obtained from test pits so located to provide a representative sample of the entire ore body.

Pilot plant facilities at Chemico's Linden laboratory were of adequate size to give reliable process and design information on the further treatment of the concentrate to produce nickel and cobalt metals from solutions.

A report by Sanderson and Porter summarizes the results of this work as follows:

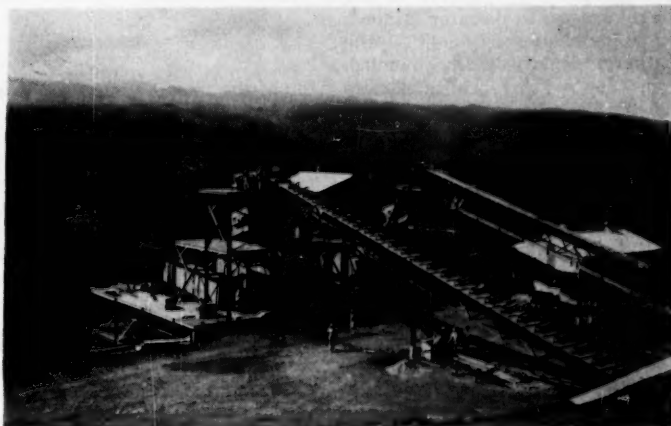
"The data from the operation of the Hoskins Mound pilot plant confirmed the technical feasibility of the process through the production of a precipitated concentrate. Sufficient concentrate was produced at Hoskins Mound to permit carrying

out, at the Linden pilot plant, two successful campaigns to test nickel-cobalt separation and metals production. These campaigns, conducted between Oct. 1954 and Jan. 1955, successfully demonstrated the technical feasibility of these parts of the overall process."

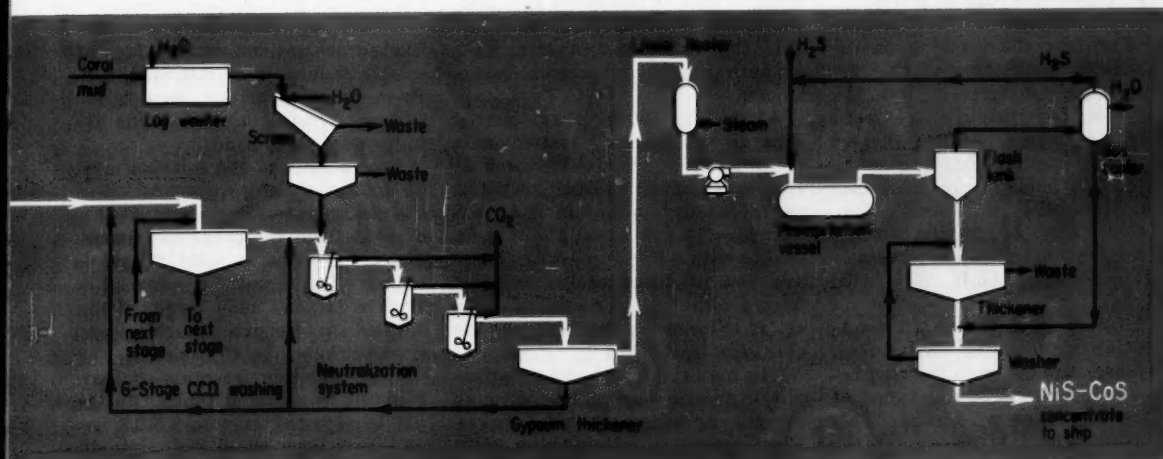
After pilot plant operation was completed, Freeport made a contract with the U. S. Government for purchasing the metal (see "Freeport's Nickel Project" by J. Carrington, p. 11). The Port Nickel, La., refinery and the Cuban Moa Bay plant were financed by Freeport.

There's an estimated reserve of substantially more than 50 million tons of this nickel-bearing ore (or looking at it another way, a 20-25 year supply at the projected processing rate of 2 million tons/year).

From an economic standpoint, it was essential to split the process into two separate plants. Preparation of the final product requires large volumes of  $NH_3$  and hydrogen. Economics of this, demands cheap natural gas for both the process hydrogen and hydrogen for  $NH_3$  synthesis. Therefore, one plant is in Cuba for treating the ore and producing a "shipping concentrate"



ORE is slurried at the mine site, then pumped to the plant.



and another plant at Port Nickel, La., to treat this concentrate and produce pure nickel and cobalt metals.

### It Starts in Cuba

Ore is never ground. After scalping out large rocks it's slurried with water in log washers, then screened at 20 mesh. Oversize is rejected. Larger material is low in nickel and not worth processing. This amounts to only 10% of the ore mined. The balance is handled as 25% solid slurry.

This free-flowing liquid is transported by pipe (about 14,000 ft.) to the processing plant. A 24-in. buried concrete pipe is laid on a 1½ grade to take advantage of gravity flow. Velocity is 8 ft./sec.

At the plant site, slurry is fed into thickeners to dewater it down to a solids content of 45-48%—the maximum density easily handled. From the two raw-ore thickeners (325-ft. dia.) it is fed by gravity to the leaching section.

### Leaching Is the Key

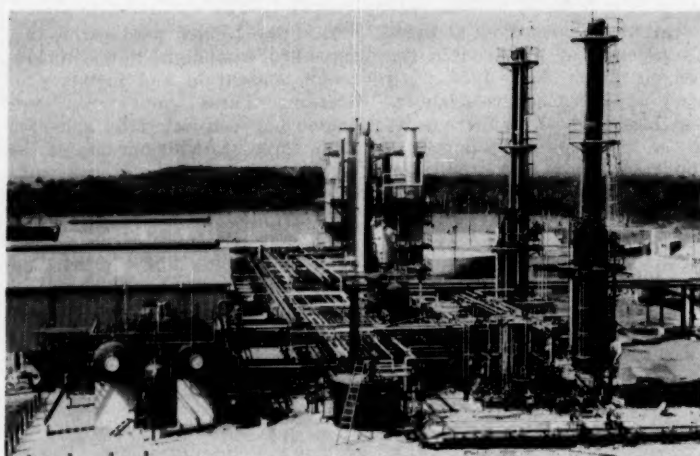
Because of the economics of heating the material, it is preheated to 180 F. using recovered, low-pressure steam (15 psig.). Special pumps move the slurry into the heater and then to the leaching vessels.

Pumps used are high pressure (diaphragm type), driven by steam turbine and have a normal throughput of 500 gpm., 650 lb. discharge pressure (*Chem. Eng.*, Mar. 1956, p. 238).

Feed rate is 5,500 tons/day of ore (dry basis) as a 45% slurry. This makes 11,500 tons/day of slurry.

Ore stream is split into four parallel lines for the leaching operation. Each line consists of four reaction vessels in series. First, the slurry is fed through a "head tower"—a direct contact heater where the slurry is brought up to the reaction temperature by contact with high-pressure steam. Then, the slurry flows by gravity through the leaching vessels. These vessels are cigar-shaped, 50-ft. high with 9-ft. I.D.

Agitation is provided by means of concentric mounted draft tubes. High-pressure steam is injected below the bottom of these tubes at a rate to induce circulation. This agitation steam is drawn off the



AUXILIARY PLANT supplies H<sub>2</sub>S for preparing the concentrate.

top of the reactors and used to heat the incoming slurry.

Pilot plant investigations showed that this system of agitation gives results equivalent to a perfectly staged continuous stirred tank system.

Reagent acid is pumped as 98% H<sub>2</sub>SO<sub>4</sub> into the first vessel of each line.

This is an extremely corrosive system. The only structural metal found capable of withstanding it, is titanium. An A-55 and A-75 grade (commercially pure) are used for draft tubes and their hardware, and interstage piping.

Vessels themselves are steel with homogeneously bonded lead lining. Lead is protected by a course of acid brick and a course of carbon brick. (This is described in *Chem. Eng.*, Jan. 26, 1959, p. 130.)

In this leaching operation, 95% of both nickel and cobalt is extracted.

After the slurry has passed through the leaching system most of its sensible heat is recovered as 15 psig. steam by indirect transfer, using tubular, titanium heat exchangers (3,720 lineal ft. of ¾-in. tubing with a 0.065-in. wall). There are two of these exchangers/line with a total transfer area of 1,450 sq. ft. Slurry leaving the heat exchangers is at 270 F.

The material is reduced to atmospheric pressure by passing through ceramic or silicon carbide chokes. Flow control is attained by split-

ting the discharge stream. Approximately 90% passes through an open choke (no valve on it). Actual rate control is maintained on the bypass stream where the control valve is actuated by liquid level in the fourth reactor stage.

Three things in the system requiring special solutions were: the high-pressure slurry pumps, the method of agitating the vessels, and the method of heat recovery.

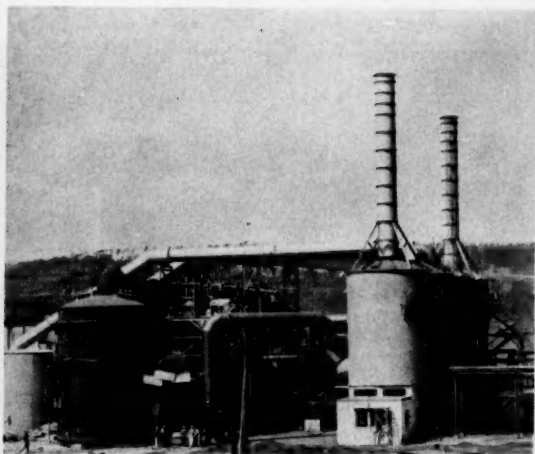
### Wash and Neutralize

After leaving the leaching system, the slurry is made up of 35% barren solids and the solution phase containing nickel, cobalt and a small concentration of iron, aluminum, magnesium and chromium. It also contains 25 g./l. of free H<sub>2</sub>SO<sub>4</sub>.

Liquid is recovered and the leached ore residue washed free of soluble values in a standard, six-stage, countercurrent decantation system. Washed leached solids are impounded in a pond.

Free acidity of the solution must be destroyed before preparation of the concentrate. To do this, CaCO<sub>3</sub>, derived from the coral reef immediately offshore, is used. Coral is recovered by dredging, screened to remove trash and large shells, washed to remove chlorides and then thickened to 40% solids.

Neutralization reaction is carried out in agitated tanks. As the pH is adjusted only to 2.5-2.8, reaction is very rapid and virtually



SULFURIC ACID plant uses waste steam for heat.



SHIP transports slurry concentrate to the U.S.

complete utilization of the  $\text{CaCO}_3$  is obtained.

Gypsum precipitate is settled out in thickeners and then added to the fresh slurry from the leach system to be washed simultaneously with leached ore residue.

#### Novel Handling of Concentrate

Neutralized liquor is treated with  $\text{H}_2\text{S}$  to recover over 99% nickel and cobalt as a concentrate. This is shipped to the refinery at Port Nickel, La.

To make this concentrate, the liquor is preheated in direct contact heaters and pumped into an agitated pressure vessel. Pure  $\text{H}_2\text{S}$  is added and the reaction carried out to precipitate virtually all of the nickel and cobalt.

To control the precipitate's particle size, twice the "make" is recycled as a heavy slurry through the reaction vessel. Treated slurry is flashed to atmospheric pressure through chokes similar to those in the leaching system and excess  $\text{H}_2\text{S}$  is cooled and recycled.

Sulfide precipitate is recovered in thickeners and washed free of contaminants in two stages. This precipitate is handled and stored as a 65% solids slurry.

One of the novel developments is handling of the concentrate. A ship was converted to transport the concentrate in slurry form with the holds modified for this purpose. There are eight, 20-ft. dia. by 20-ft.

deep, rubber-lined tanks to contain the concentrated slurry. This ship was also fitted with liquid sulfur tanks and tanks to carry LPG on the return trips from the U.S.

Auxiliary units comprise an  $\text{H}_2$ - $\text{H}_2\text{S}$  unit (largest of its kind in the world) and a contact  $\text{H}_2\text{SO}_4$  plant (one of the 10 largest in the world) as well as the usual power plant, etc.

The  $\text{H}_2$ - $\text{H}_2\text{S}$  facility, built by Girdler, is designed to supply the high purity  $\text{H}_2\text{S}$  to the concentrate preparation section. Liquefied petroleum gas is reformed with steam to make hydrogen and is reacted directly with liquid sulfur to make  $\text{H}_2\text{S}$ . Capacity is 60 tons/day of  $\text{H}_2\text{S}$ .

In the acid plant, 50% of the high-pressure process-steam requirements are generated through the waste-heat recovery system. This plant has a capacity of 1,300 tons/day.

#### Then: To the U. S. and Oxidation

When the ship docks at Port Nickel, the concentrate slurry is resuspended and pumped to storage at the plant site. It is recovered from storage and moved to refinery feed tanks as required.

No attempt is made to keep the concentrated slurries suspended while in storage. They are permitted to settle until it's desired to move them. An especially designed agitator with an impeller that can

be raised and lowered is used to resuspend the solids. At 65% solids, the slurry is very fluid and can be handled as easily as water (this is a special development in the process).

First step in processing the concentrates is to redissolve them. This is done by oxidizing sulfides to sulfates in suspension using air at high pressure and elevated temperatures. A single stage is used and the necessary rate of solution obtained by feeding a substantial excess of solid sulfide. This excess is recovered and recycled using a small thickener.

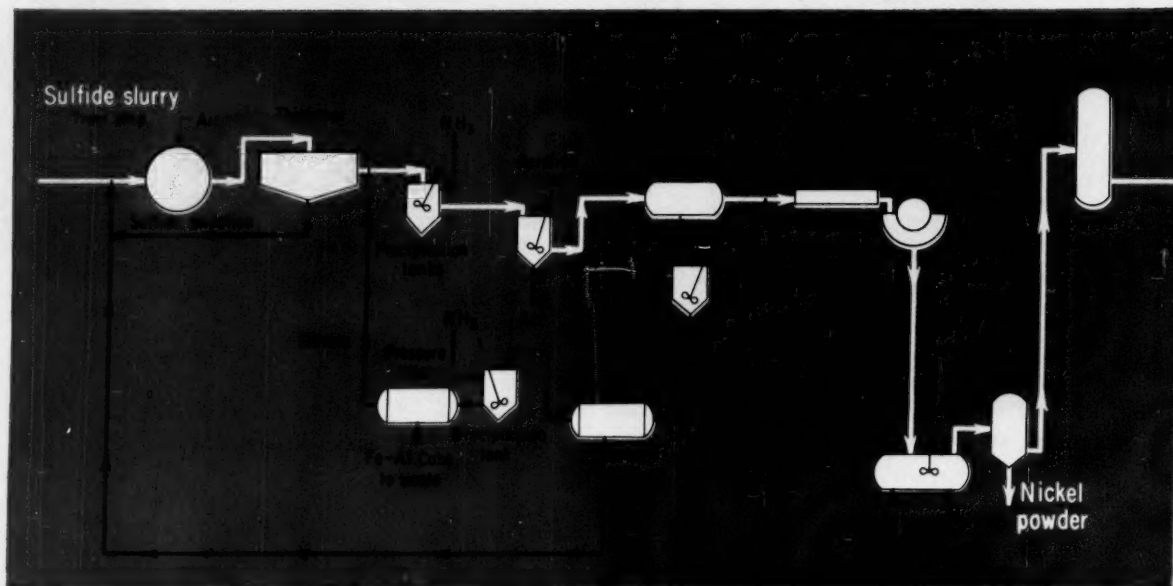
Reaction vessels are spherical, lead-lined steel with acid brick. Agitators and other parts are titanium since the system is about as corrosive as the ore leaching systems at Moa Bay.

#### Accessory Metals are Removed

Leached solution is controlled at about 50 g./l. of nickel, and 5 g./l. cobalt. Sulfide feed contains small amounts of iron, aluminum, chromium, cobalt, zinc and lead. Therefore, the solution must be purified before preparing the nickel product.

Iron, aluminum and chromium are removed by adjusting the pH to 5.5 with  $\text{NH}_3$ . Aeration converts ferrous iron to ferric and these metals are filtered out using leaf-type pressure filters.

The pH is readjusted to 1.5 with  $\text{H}_2\text{SO}_4$ ; then, copper, lead and half of the zinc are removed with  $\text{H}_2\text{S}$ . This



reaction is carried out in a rubber-lined pipe. Resulting precipitate is removed on precoat vacuum drum filters.

At this point, the solution contains nickel, cobalt and a small

amount of  $(\text{NH}_4)_2\text{SO}_4$ . It is preheated and directly reduced with hydrogen gas at high pressure. The pH is controlled by pumping anhydrous  $\text{NH}_3$  into the reaction vessel.

Under these controlled conditions,  $\pm 95\%$  of the nickel is precipitated as metal powder.

This operation is batch-wise and precipitation of the nickel requires seeding. To do this, the first batch in a series is treated with a nucleation catalyst. This gives an extremely fine seed powder. Contents of the vessel are blown into a separator where seed powder settles and is returned to the reaction vessel.

Reduced liquid goes to further processing.

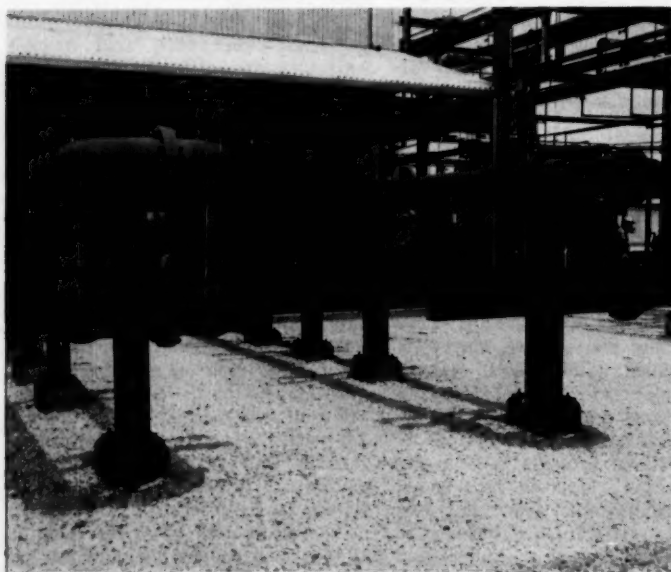
Subsequent densifications on the seed are made under the same conditions but without the catalyst. In these cases, after nickel reduction is complete, the agitators are shut off and the metal permitted to settle.

Reduced liquid is decanted and the fresh charge is then added to the autoclave or reaction vessel.

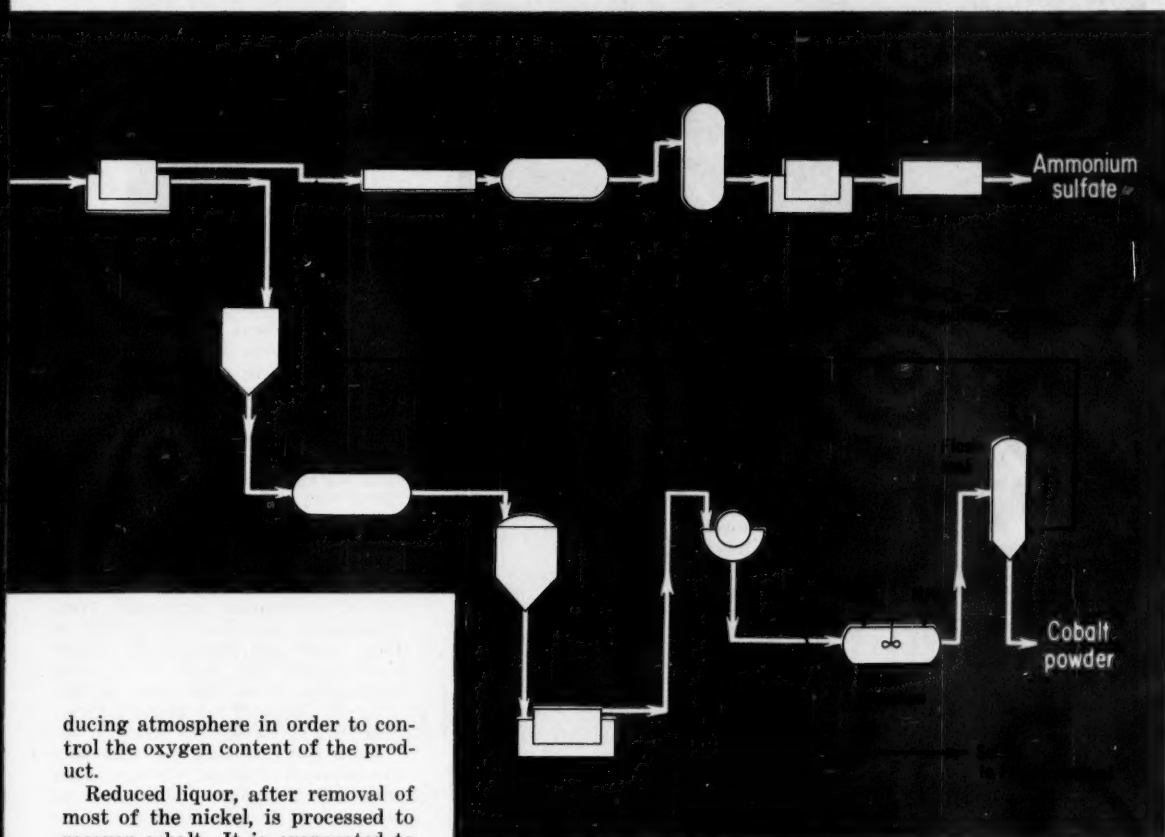
#### Final Products: Ni and Co Metal

After the series of densifications is complete, the agitators are left on and the nickel powder slurry is blown out to a separator.

Powder is separated out, washed, dried, briquetted and sintered to make the final product. Drying and sintering must be done under a re-



PIPELINE REACTOR removes copper, lead and zinc with  $\text{H}_2\text{S}$ .



ducing atmosphere in order to control the oxygen content of the product.

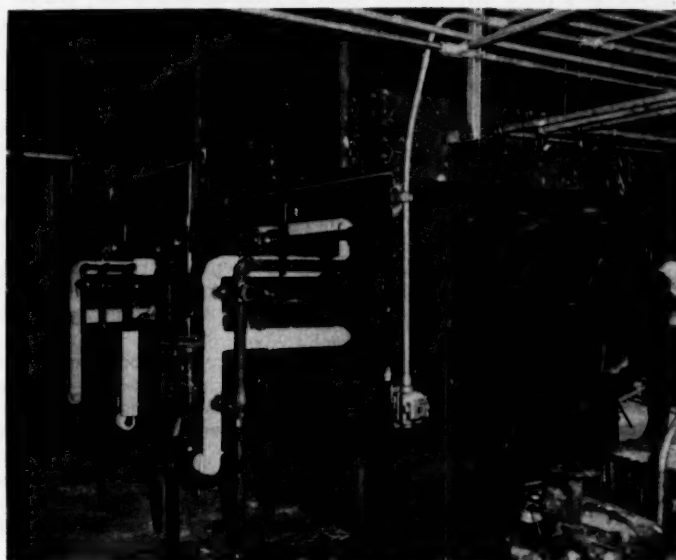
Reduced liquor, after removal of most of the nickel, is processed to recover cobalt. It is evaporated to a mother liquor concentration of 500 g./l. of  $(\text{NH}_4)_2\text{SO}_4$ , which precipitates the cobalt, residual nickel and a small amount of zinc as double sulfate.

These are separated by centrifuging, redissolved in water and anhydrous  $\text{NH}_3$  is added.

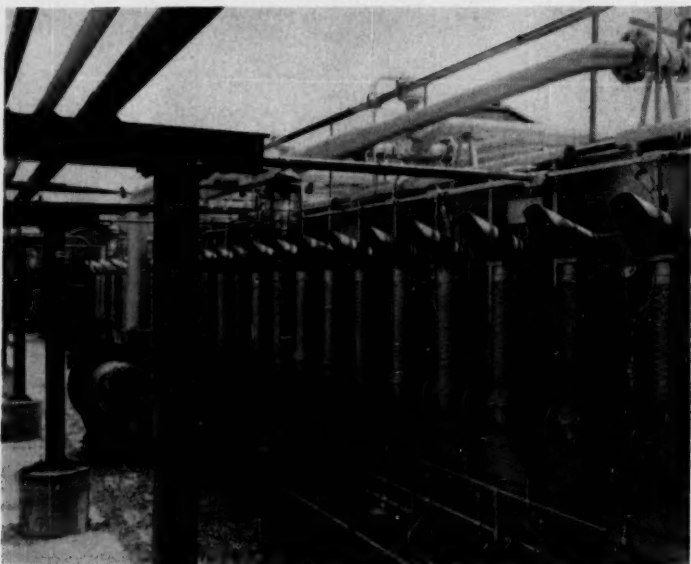
Resulting solution is treated with air at high pressure in an oxidation autoclave, converting the cobalt from the divalent to the trivalent state where it is firmly complexed by the ammonia. This complex is so stable that upon adjusting the pH with  $\text{H}_2\text{SO}_4$ , the complex cobalt remains in solution while the nickel and zinc are reprecipitated as the double  $(\text{NH}_4)_2\text{SO}_4$ .

Bulk of the crystals are removed by centrifuging and the overflow is polish filtered on a precoat vacuum drum filter. Polished solution contains a cobalt to nickel ratio of greater than 300 to 1.

Crystals from the centrifuge and precoat filter are recycled back to the iron and aluminum removal step where the metal values are redissolved and the filter aid re-



OXIDATION AUTOCLAVE forms a cobalt complex using air and  $\text{NH}_3$ .



DRYING AND SINTERING under a reducing atmosphere are the final process steps in preparing cobalt and nickel powders.

jected with the iron and aluminum cake.

This solution is reduced to cobalt metal powder using essentially the same techniques and conditions as are applied to the nickel. This powder is also handled similarly to the nickel powder.

#### Byproduct Ammonium Sulfate

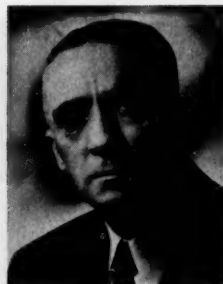
Mother liquor from the crystallization of the cobalt double salt and the residual liquor from cobalt reduction are combined for recovery of  $(\text{NH}_4)_2\text{SO}_4$ . They are stripped of residual metals by treatment with  $\text{H}_2\text{S}$  followed by filtration using pressure filters.

The  $(\text{NH}_4)_2\text{SO}_4$  evaporation has

been designed into the same unit used for the preliminary double salt evaporation so that the economics of six evaporator effects have been obtained. Liquor streams, of course, are kept separate while the vapor system has been integrated. Normal  $(\text{NH}_4)_2\text{SO}_4$  production is 280 tons/day.

Filter cake containing iron and aluminum also contain soluble nickel and cobalt. This material is redissolved with acid and reprecipitated with  $\text{NH}_3$  to recover the soluble nickel and cobalt metal values that are in it.

At Port Nickel the  $\text{H}_2\text{S}$  plant is similar to the one in Cuba, except in size. The unit at Port Nickel has a capacity of only 2 tons/day.



J. A. LEE has been the Southwestern Editor for *Chemical Engineering* and *Chemical Week* in Houston since 1949. His article on the Freeport Nickel Co. operation caps a long and distinguished career as practicing editor, author and active participant in technical society and civic affairs. Now Jim is retiring and the story you have just read is his last as an active member of our staff.

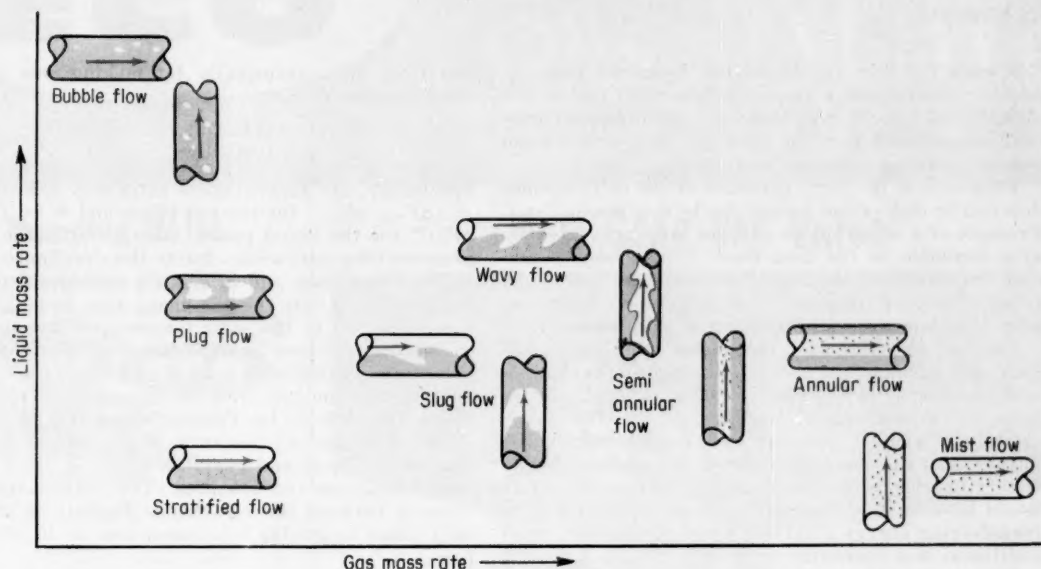
Jim was born in New Iberia, La., on Aug. 7, 1894. He obtained his BA and BS in chemical engineering from Washington and Lee University in 1917, spent one year at MIT, then received his MA, also in chemical engineering, from Columbia in 1924 after serving with the Chemical Warfare Division of the US Army.

Jim's first full-time job was with the Western Electric Co. and later with Bell Telephone Labs where he worked as a chemical engineer in the development of electrical insulating materials.

In 1929, Jim left Bell Telephone and joined *Chemical & Metallurgical Engineering* as an assistant editor. He was made managing editor in 1933 and was appointed Southwestern editor and manager of the McGraw-Hill news bureau in Houston in 1949. He has filled these positions with distinction since that time.

In addition to his duties as regional editor and former managing editor, Jim also counts among his achievements authorship of a book, "Materials of Construction for Chemical Process Industries," and many articles. He was consulting editor for the McGraw-Hill Chemical Plant Library, national president of the Electrochemical Society in 1948-49 and chairman of the TAPPI Materials of Construction and Chemical Raw Materials committees. He also found time for active participation in the AICHE, ACS, ASTM, the Houston Chemical Club, and was the AICHE representative to the Houston Engineer's Council.

As a "galvanized Texan" Jim had to acquire either oil wells or cattle. He did both. Now, with his retirement on September 1, he will be able to devote more time to his hobby as an amateur cattle rancher.



## CE Refresher

# How to Analyze Two-Phase Flow

Apply these special methods for handling flow relations  
to your analysis and computations of multiphase flow.

JESSE COATES and BERNARD S. PRESSBURG, Louisiana State University, Baton Rouge, La.\*

WHEN two or more phases move simultaneously in the same direction through a conduit such as in an air lift, in pneumatic conveyors or in certain types of reboilers and condensers, the mechanisms of flow and the relation between rate and potential may become more complex. In general, the presence of a second phase increases the pressure drop manyfold over what it would be if only one phase were flowing at the same mass rate.

Before considering the details of multiphase flow, we should note that not all two-phase mixtures behave in the same manner. As exemplified by suspensions of solids in liquids, many mixtures flow as a homogeneous material. The major problem associated with homogeneous materials is prediction of their physical properties.

Alternatively, liquid-vapor mixtures ordinarily do not move as a whole but, instead, one phase moves relative to the other. The denser phase tends to move slower and requires more time to traverse the same length of pipe. Our discussion is concerned only with systems that fall in this category.

Numerous investigators who studied this problem

present case histories in which they described both qualitatively and quantitatively the observed-flow mechanisms. It has been well established that there are many flow patterns whose mode depends on the relative as well as on the absolute rates of the two phases.

For example, if to a constant flow rate of liquid a relatively small proportion of gas is added, the gas breaks into small bubbles which remain discrete as they flow through the liquid. As the proportion of gas is increased, the number and size of the bubbles increase and they tend to join, giving alternate slugs of liquid and gas. At still other proportions, the gas may move through the pipe as a continuous column with the liquid surrounding it as an annulus. Further increases in the gas ratio ultimately lead to the point where the gas is the continuous phase and the liquid is dispersed through it as a mist.

These modes are known to occur in both vertically and horizontally oriented piping. In addition, stratification may occur in horizontal flow with the lighter phase occupying the upper portion of the tube and the denser the bottom. Sketches of these various modes are shown in the above diagram.

This behavior can be correlated for any one system.

\*To meet your authors, see *Chem. Eng.*, May 18, 1959, p. 182.

But even for this, the transition from one mode to another occurs over a range of flow rates and is not sharply defined. Hence, there are no universal generalizations such that the behavior of a new system can be predicted with any certainty.

Reasons for the high pressure drops in two-phase flow can be understood in view of the flow mechanisms. Presence of a second phase reduces the transverse flow area available to the first fluid. Thus, velocity and flow resistance of the first fluid increase, just as if it were passing through a smaller pipe. Since the area is seldom circular, this effect is more pronounced.

Further, interaction of the phases must be considered. For example, the energy consumed in overcoming surface tension in the creation of additional surface area, or momentum exchanged, or the turbulence caused by contact between two phases moving at unequal rates are displays of this interaction. If the energy balance were applied to each fluid, these effects would have to be accounted for, either as a work term transferring energy from one phase to another, or as additional flow resistance or both.

Considering the many unknowns such as number and size of the bubbles or drops, and shape and size of the flow area for each fluid, we can understand why there is no theoretical solution that defines the flow-potential relationship as Poiseuille's law does in streamline flow or even a satisfactory empirical one analogous to Fanning's equation. The major incontestable fact of any significance is that the pressure drop is essentially the same for both phases. Because of the difference in density of the different phases, this corresponds to widely different energy consumptions ( $F$ ).

Extensive research is being carried out in this field at the present time. Ultimately, this research should put quantitative treatment of multiphase flow on as firm a basis as single-phase flow. In the meantime, each type of multiphase system such as liquid-gas, liquid-liquid or solid-gas is considered separately.

### How to Correlate Multiphase Flow

For multiphase flow, the most workable methods now available are those for liquid-gas systems. These are based on the work of Lockhart,<sup>1</sup> Martinelli,<sup>2</sup> and their coworkers. As shown by Fig. 1, they correlate

empirical data graphically by making use of two dimensionless ratios.

$$X = (\Delta P_L / \Delta P_G)^{0.5}$$

$$\Phi = (\Delta P_{TPF} / \Delta P_{One\ phase})^{0.5}$$

Specifically, the dimensionless ratio  $\Phi$  is defined as  $\Phi_G = (\Delta P_{TPF} / \Delta P_G)^{0.5}$  for the gas phase and  $\Phi_L = (\Delta P_{TPF} / \Delta P_L)^{0.5}$  for the liquid phase. Also  $\Delta P_{TPF}$  is the actual pressure drop that occurs due to the simultaneous flow of the two phases and  $\Delta P_G$  is the pressure drop that would occur if only the gas phase were flowing at the same rate and at the same temperature and pressure conditions as it does in two-phase flow. For the liquid phase,  $\Delta P_L$  is defined similarly as  $\Delta P_G$ .

Since  $\Delta P_G$  and  $\Delta P_L$  are easily evaluated either by Poiseuille's law or by Fanning's equation,  $X$  can be shown to depend on the ratio of the weight rates of flow of the liquid and gas phases and on the ratio of their viscosities and densities. The quantitative relationship between these variables depends on whether each phase is moving in viscous flow or in turbulent flow.

Accordingly, there are four lines in Fig. 1 for each phase. The correct line to use depends on the flow classification of the separate phases. For example, if both phases are viscous, we evaluate  $X$  and read  $\Phi_{vv}$  from Fig. 1. Evaluate  $X_{vv}$  from the relation:

$$X_{vv} = \left[ \left( \frac{w_L}{w_G} \right) \left( \frac{\mu_L}{\mu_G} \right) \left( \frac{\rho_G}{\rho_L} \right) \right]^{0.5}$$

Determine phase viscosity from the relation:  $4w/\pi D\mu < 1,000$  for viscous flow.

Alternatively  $X_{tt}$  and  $\Phi_{tt}$  would be used if both phases are turbulent where  $4w/\pi D\mu > 2,000$ . Use  $X_{vt}$  and  $\Phi_{vt}$  if the liquid phase is viscous and the gas phase turbulent, or  $X_{tv}$  and  $\Phi_{tv}$  if the reverse is true.

This arbitrary classification and grouping of the available experimental data improves the correlation. Nevertheless, individual observations deviate from the best statistical correlation by as much as 50% probably because  $X$  is expressed as a ratio which may have different  $\Phi$  values. Although  $X$  values may be the same,  $\Phi$  values depend on the actual flow rates and thus on the flow pattern and degree of turbulence. Solving a typical problem illustrates the use of Fig. 1.

Air and water at 70 F. flow simultaneously through a 1-in. standard steel pipe. Air flow is 500 lb./hr. and water flow is also 500 lb./hr. Calculate the pressure gradient  $(\Delta P / \Delta L)_{TPF}$  at the point where the pressure in the pipe is 50 psia.

Additional data for this problem follow:

	Liquid Phase	Gas Phase
Viscosity, centipoise.....	0.981	0.0178
Density, lb./cu. ft.....	62.3	0.254
Linear velocity, fps.....	0.372	91.0

Note that we assume single-phase flow in expressing the linear velocity for each phase.

Calculate the Reynolds number for each phase using consistent units in the relation  $N_{Re} = 4w/\pi D\mu$ . For liquid phase  $N_{Re} = 3,080$  and for gas phase  $N_{Re} = 169,000$ . If roughness ratio equals 0.0018, use friction factor graph in *Chem. Eng.*, July 13, 1959, p. 153, to find friction factors. For liquid phase  $f$  is 0.011 and for gas phase  $f$  is 0.0060.

Since the Reynolds number for each phase indicates

### Nomenclature

$D$	Pipe diameter, ft.
$F$	Fluid friction, ft.-lb./lb.
$g_c$	Conversion factor = 32.2 ft.-lb. mass/(lb. force) (sec. <sup>2</sup> ).
$L$	Pipe length, ft.
$N_{Re}$	Reynolds number.
$P$	Pressure, psi.
$r$	Pipe radius, ft.
$v$	Fluid velocity, fps.
$w$	Flow rate, lb./sec.
$X$	Dimensionless ratio for two-phase flow.
$\Delta P_f$	Pressure drop due to friction, psi.
$\Delta P_G$	Pressure drop for gas phase only, psi.
$\Delta P_L$	Pressure drop for liquid phase only, psi.
$\Delta P_{TPF}$	Pressure drop for two-phase flow, psi.
$\mu$	Fluid viscosity, lb./sec.-ft.
$\rho$	Fluid density, lb./cu. ft.
$\tau$	Shear force/area, lb./sq. ft.
$\Phi$	Dimensionless ratio for two-phase flow.

# ECO

# ENGINEERING

# NEWS

VOL. 1, NO. 4

*the big name in small pumps for the process industries*

## Pumping Notes

World-Wide Demand



**Rollkolbenpumpe**

(self-actuating)

Material: C<sub>2</sub> - Rostfreier Stahl  
Manell oder Marinebronze

Rollkolben aus:  
TEFLON, HYFALON, NEOPRENE,  
FORMICA, BRONZE, GRAPHIT

Generalvertretung

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ECO pumps are being sold in 47 different countries, outside of the "Iron Curtain."

Interesting examples are 316 Stainless Steel ECO GEARCHEM® Pumps with TEFLON† trim for handling ethylene dichloride and nitroglycerine, ordered by Nitroglycerine Aktiebolaget, Gytörp, Sweden—the business founded by Alfred Nobel of the world famous Nobel Peace Award.

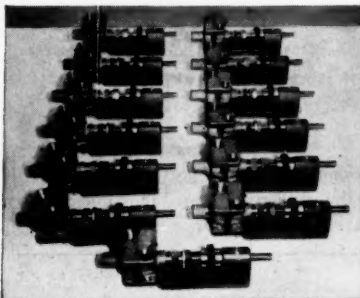
Also—a recent order for 14 ECO ALL-CHEM® Carpenter-20 Stainless Pumps from India, for Atomic Energy applications.

And another application of ALL-CHEM Pumps by Aktiebolaget Bofors of the 2nd World War Bofors Gun fame.

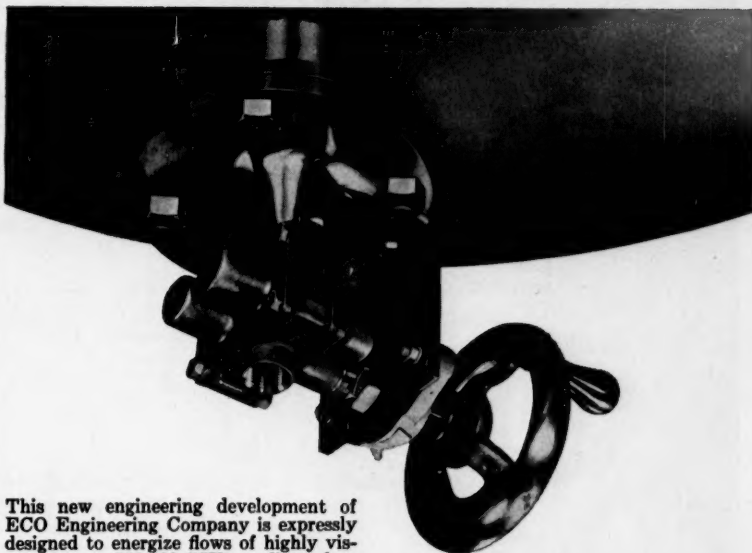
ECO Export Sales are under the direction of Mr. Joseph Rizzo, Empire State Building, New York, N.Y., U.S.A.

### ECO Midgets Serve Green Giant

Thirteen ECO ALL-CHEM 316-Stainless Steel Pumps with Neoprene impellers, carbon bearings and chemically impervious TEFLON Packings are helping to pack Green Giant Corn, Peas and other delectable vegetables at Le Sueur, Minnesota. These little pumps handle seasoning and preservatives. They offer positive non-contamination of taste, aroma, color and purity of product; provide greater dependability and much longer service life than previous pumps.



## New GEAR-VAC Valve\*



This new engineering development of ECO Engineering Company is expressly designed to energize flows of highly viscous (up to 250,000 SSU) media and to dispense them with positive metering accuracy in volumes up to 2 gpm. To accomplish this, the GEAR-VAC Valve produces almost absolute vacuum, causing the viscous mass to collapse into the vacuum pocket, providing a constant supply in the gear chamber for positive dispensing with reproducible metering accuracy within  $\pm 2$  percent.

### Revolutionary Advantages

The ECO GEAR-VAC Valve offers a novel and distinct contribution to process equipment technology.

It eliminates the need for heating such viscous media before passing through the valve as is the case with cumbersome plug valves. It also eliminates sluggish and time-consuming gravity feed of such media.

### Linear, Bubble-Free Flows

Flows are linear, bubble-free and can be accurately varied at will—as contrasted with the performance of plug valves which, when used to control flow, yield greatly reduced, lumpy and spasmodic flows. ECO GEAR-VAC Valves, instead of restricting passage of media, develop

reduced flows by correspondingly reducing the RPM of the gear mechanism. Also, when used to dispense highly viscous, adhesive or cohesive media, there is no leakage past the gear train. Hence it performs like any plug, check or shut-off valve in positively stopping flow of media.

### Manual or Motor Operated

ECO GEAR-VAC Valves are offered with handwheel for manual operation (where the amount dispensed may be determined by the handwheel travel), and motor-operated with pulley, sprocket wheel or flexible shaft drive, for remote or process-controlled operation on constant or cyclic flows.

### Simplicity of Design

This unit represents features of design which offer rapid and complete accessibility to bearings and gear train. It regularly features standard 150 lb. ASME 3 in. flange on suction side for connection to tank, reactor, etc. Tapered conical suction port design offers minimum resistance to sluggish media. Threaded discharge port is  $\frac{3}{4}$ ".

## ECO Products for Handling Corrosive and Hazardous Processing Fluids

ALL-CHEM Rotary Pumps

MINILAB Rotary Pumps

GEARCHEM Gear Pumps

CENTRI-CHEM Centrifugal Pumps

PUMPMOBILE Portable Pumping Units

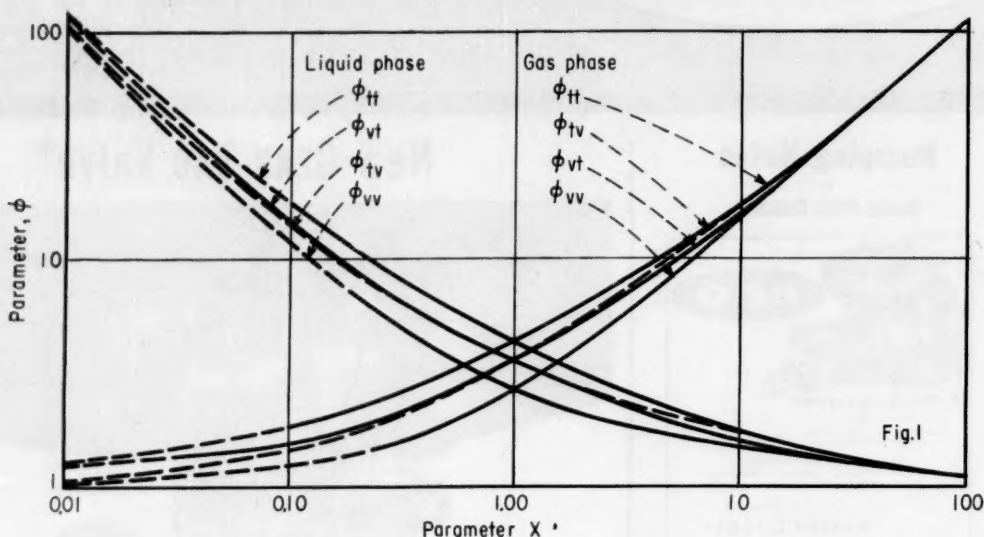
CHEMICAL FAUCETS Factory Mutual Approved

Ask for literature on any or all of these ECO Products

\*Trademark applied for †duPont Trademark

ECO ENGINEERING COMPANY • 12 New York Avenue • NEWARK 1, N.J.

## Use Dimensionless Ratios to Find Pressure Drop in Two-Phase Flow



turbulent flow, use the Fanning equation to calculate pressure drop,  $\Delta P = 4fv^2L\rho/2g_c D$ .

For liquid phase:

$$\frac{\Delta P}{\Delta L} = \frac{4 \times 0.011 \times (0.372)^2 \times 62.3}{64.4 \times 1.049/12 \times 144} = 0.000468 \text{ psi./ft.}$$

For gas phase:

$$\frac{\Delta P}{\Delta L} = \frac{4 \times 0.0060 \times (91)^2 \times 0.254}{64.4 \times 1.049/12 \times 144} = 0.0625 \text{ psi./ft.}$$

We can now calculate the value of the dimensionless ratio  $X$ .

$$X = [(\Delta P/\Delta L)_L / (\Delta P/\Delta L)_G]^{0.5} \\ X = (0.000468/0.0625)^{0.5} = 0.0864$$

From Fig. 1, we find the value of the dimensionless ratio  $\Phi$  for each phase. For the liquid phase  $\Phi_{ll} = 22$  and for the gas phase  $\Phi_{gg} = 1.8$ .

Using the relation  $\Phi^2 = \Delta P_{TPP} / \Delta P_{One\ phase}$ , we calculate the pressure gradient for each phase.

$$(\Delta P/\Delta L)_{TPP} = (22)^2 (0.000468) = 0.225 \text{ psi./ft. based on the gas phase.}$$

$$(\Delta P/\Delta L)_{TPP} = (1.8)^2 (0.0625) = 0.203 \text{ psi./ft. based on the liquid phase.}$$

Theoretically, the pressure gradients should agree exactly for each phase. The difference here reflects the accuracy with which Fig. 1 can be read.

## Consider Flow of Non-Newtonian Fluids

This discussion of special flow cases is not complete without inclusion of fluids which do not conform to the simple shear relationship:

$$\tau g_c = \mu dv/dr \quad (1)$$

While Eq. (1) satisfactorily describes the behavior of fluids such as water, oil, alcohol, gases and vapors, it does not describe the behavior of gels, polymers,

slurries and similar materials. All of the latter materials deviate in one way or another from the above relationship.

Interaction of fluids particles accounts for the behavior of non-Newtonian fluids. This interaction which takes many forms is generally mechanical and results from the size and shape of the molecules. For example, the behavior of an ideal plastic may be explained as the settling and compact interlocking of molecules which must be overcome by a force. Once the interlocking is overcome, the force is no longer a factor and the material behaves like a Newtonian fluid. Similar physical pictures have been postulated for the other non-Newtonian fluids.

Many of these fluids are also thixotropic or rheopectic. In these fluids, the properties and behavior of the fluid under specific conditions depends on the previous force and motion to which the fluid has been subjected.

Hence, the analysis of published data and the development of quantitative relationships in this field have been slow. It is only in recent years that the work of Metzner<sup>3</sup> put the relationships on a sound and quantitative basis.

## REFERENCES

1. Lockhart, R. W. and R. C. Martinelli, "Proposed Correlation of Data for Isothermal Two-Phase Flow," *Chem. Eng. Progress*, Jan. 1949, p. 39.
2. Martinelli, R. C. and others, *Trans. ASME*, 66, 139 (1944).
3. Metzner, A. B., "Advances in Chemical Engineering," Vol. 1, p. 79, Academic Press, Inc., New York (1956).

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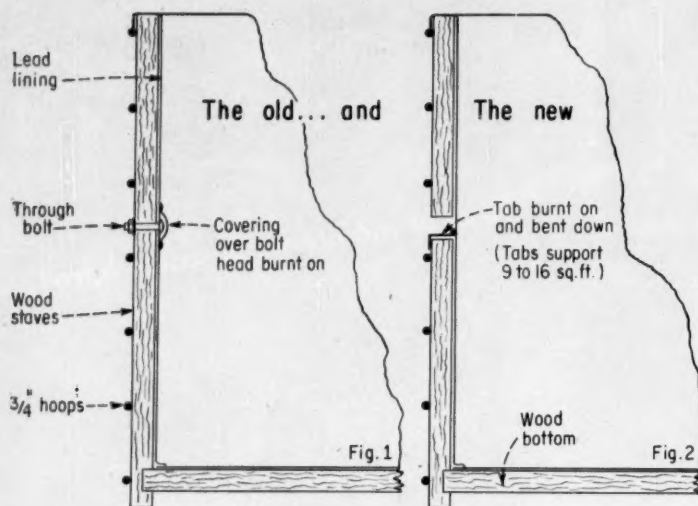
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## Better Way to Lead-Line Your Wooden Tanks

Usual method is too rigid, makes trouble spots when temperatures vary; lead-tab method shown here has worked for 15 years without trouble.

★Winner of the Midsummer Contest by  
Albert E. Hughes

Research Laboratory, Rumford Chemical Works, Rumford, R. I.

Sketched above are two methods of securing a lead lining within a wooden tank. The method on the left is the conventional one, while that on the right is an improved method I have used successfully for the past 15 years. It provides a flexible means of attachment which avoids trouble due to expansion and contraction of the lead with changes in temperature.

In Fig. 1, the conventional method, the lead lining is fastened to the side of the wooden tank by bolting through and then covering the head of the bolt with sheet lead which is burned around to make it tight. This method is satisfactory if there are no temperature changes. However, in normal chemical plant use with hot liquids, such a bolt holds the lining too rigid,

causing a buckling tendency and producing a trouble spot with continued expansion and contraction of the lead.

My improved method was first used 15 years ago on 12 lead-lined tanks of 20,000 gal. capacity. These tanks, lined with  $\frac{3}{8}$ -in. lead, operate at about 236 F. and have never given the slightest trouble at the attachment points.

In Fig. 2, the new method, lead tabs burned to the lining are used instead of the through bolts. They extend out through holes cut in the tank staves and are hooked down over the staves for flexible support.

Before lining, we have a number of 3 x 3-in. holes cut through the staves. These should be on 3- to 4-ft. centers. For example, in a tank 6 ft. high, we would put a row of holes half way up and at intervals of about 3 ft. around the periphery. In a tank 12 ft. high there would be rows of holes 4 and 8 ft. from the bottom, spaced about 4 ft. around the periphery.

The tabs are made of lead of the same weight as the lining, about 3 in. wide and 4 in. long. These are placed in the opening and burned to the lining, then turned sharply down over the edge of the staves. The 3 x 3-in. opening is necessary to give the lead burner sufficient space in which to work while he is attaching the tabs.

### This Simple Method Finds Vacuum Leaks

R W. Naylor

Senior Staff Member  
Spencer Chem. Co. Research Center  
Merriam, Kan.

Locating leaks in a vacuum system is often more difficult than repairing them, unless you have special equipment available. However, there is an easy way to check a suspected joint for leakage. It requires nothing

TITANIUM—COMING OF AGE!



## Spray dryer wheels get longer life from titanium

Titanium is chalking up large savings as a material for process industries equipment. Its corrosion resistance, strength and light weight, and easy machinability all add up to economies.

For example, the atomizer wheels, as shown above, are vital components in spray dryers manufactured by Bowen Engineering, Inc., North Branch, N. J. They turn at selected speeds between 6000 and 20,000 rpm, blasting feed liquid into fine spray to be dried by heat.

In one installation, a titanium wheel operated 2200 hours in hot calcium hypochlorite. With previously used materials the entire wheel had to be replaced after this service but only the outer basket of the titanium wheel needed replacement. In addition, the light weight of titanium greatly reduced wear on bearings in this high speed rotating part, producing further savings.

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strong, corrosion-resisting metal is coming of age as an economical answer to difficult corrosion problems.

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in the way of special equipment except some plastic film and some tape.

The idea is to wrap the joint loosely with the film and seal it with tape so as to form a "balloon." Inflate the balloon and then watch what happens to it when vacuum is applied to the system. Any leak will deflate the balloon and cause its collapse while a tight joint will leave it fully inflated.

There are various ways to get air into the balloon initially. It does not have to be under pressure and so does not have to be perfectly sealed unless the leak is very small. It may be possible to trap enough air inside the film as it is wrapped around the joint. Or you can tape a piece of rubber or plastic tubing into one of the seals, later inflating the balloon by lung power or air hose and then plugging the tube.

Although almost any type of film is suitable,  $\frac{1}{4}$ - to 1-mil polyethylene is cheap and easily

## Next Issue: Orifices Proportion Liquid to Gas Flow

By L. D. Brice, Winner of the July Contest

### ★ How Readers Can Win

**\$50 Prize for Good Idea**—Until further notice the Editors of *Chemical Engineering* will award \$50 each four weeks to the author of the best short article received during that period and accepted for Plant or Process Design Notebooks.

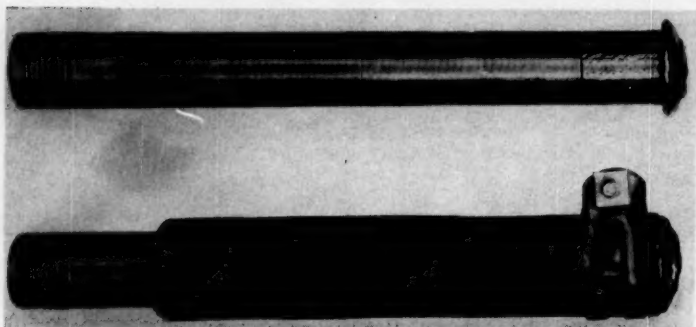
Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

**\$100 Annual Prize**—At the end of each year the period winners will be rejudged and the year's best awarded an additional \$100 prize.

**How to Enter Contest**—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable nonwinning articles will be published at space rates (\$10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Process Design Notebooks, *Chemical Engineering*, 330 W. 42 St., New York 36, N. Y.

available. Plastic garment bags work very well. Cellophane tape does a good job of sealing polyethylene, or masking tape can be used for better adhesion to pipes and valves.



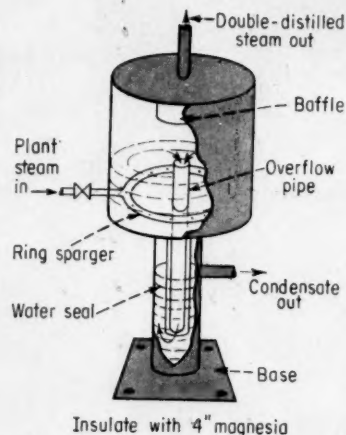
## Rubber Sparger for Solids

Robert A. Kinzie, Jr.  
Pacific Cement & Aggregates, Inc., San Francisco, Calif.

The article on p. 154 of the Mar. 9, 1959, issue which describes a nonclogging rubber sparger prompts me to call attention to a somewhat similar device we have been using successfully for the past five years to aerate cement in silos.

Other methods would clog when the air was shut off. A pipe

covered with canvas worked well, except that the canvas had a short life. The present device, shown above, consists of a piece of pure gum rubber tubing slipped over and clamped to the end of a closed-end pipe nipple. The pipe is slotted to pass air and is turned down slightly except at the end.



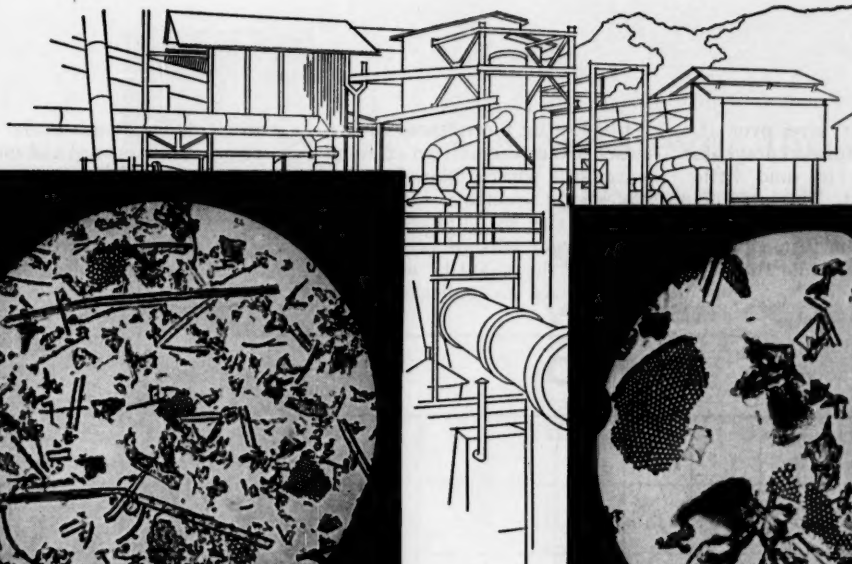
## Condensate Boiler Makes Double-Distilled Steam

H. G. Knapp  
The Nichols Chemical Co., Ltd.  
Sulphide, Ont., Canada.

Sketched above is a simple way to get a dependable supply of pure, low-pressure steam.

The idea is to use plant steam to boil its own condensate and thereby effect a second distillation. To accomplish this, steam from the plant boiler enters a  $\frac{1}{2}$ -in. pipe-ring sparger submerged in condensate which is maintained at constant level by a  $\frac{1}{2}$ -in. pipe overflow luted in the bottom leg.

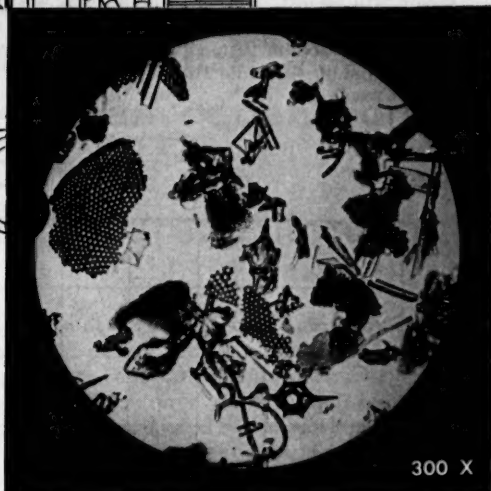
This lute or water seal forms a stand for the boiler. Where it projects down into the lute, the overflow pipe is insulated by



Milling and calcining equipment used for all Celite grades.



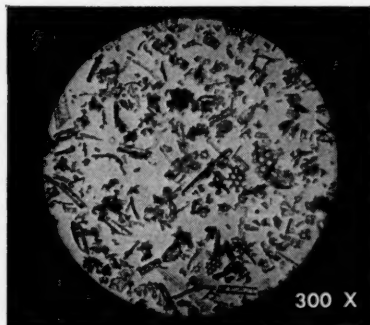
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Super Floss, one of several bag house grades, has fine particle size distribution. A white powder, it is processed within very narrow tolerances (less than 1% retained on 325 mesh). It is a popular filler in fine products such as silver polishes.

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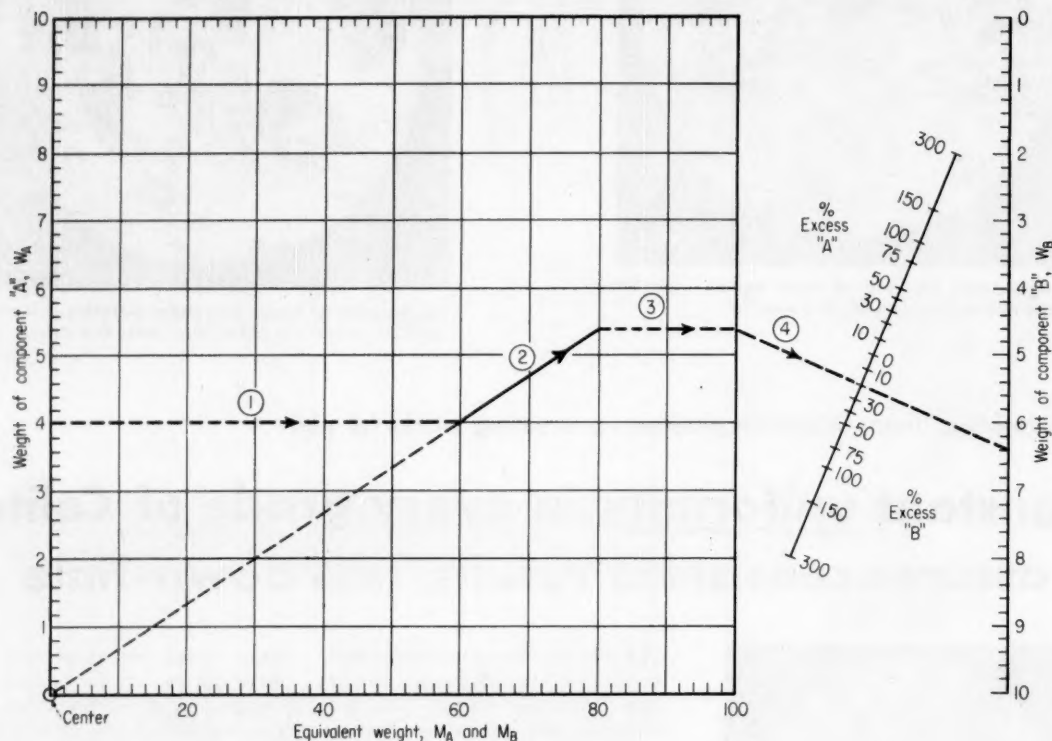


welding a larger pipe over it. The air space so formed prevents boiling in the lute and little steam will be lost. The lute acts as a safety valve and also takes care of the vacuum formed when steam is shut off while the outlet is closed.

Connecting a condenser to the outlet makes the unit an efficient water still, without blow-down or water-level problems.

What size to build the boiler and sparger will, of course, depend on the quantity of steam needed. As an indication, our

original boiler was made entirely of stainless steel and measured 18 x 18 in. It easily handles the steam formerly produced by a 20-kw. electric boiler. The entire unit is insulated with a 4-in. layer of magnesia block insulation.



## Mixing Chart for Two Components

Jerome A. Seiner

Development Engineer, Springdale Research Center, Pittsburgh Plate Glass Co., Springdale, Pa.

Shown above is a chart of the author's unique "linear-focus" type (see e.g., *Chem. Eng.*, pp. 150-152, Apr. 6, 1959), which very quickly determines the necessary weights of two reacting materials when the equivalent weights and the desired percentage excess of one material are known. The chart solves the equation:

$$W_B = (M_B/M_A) (X)$$

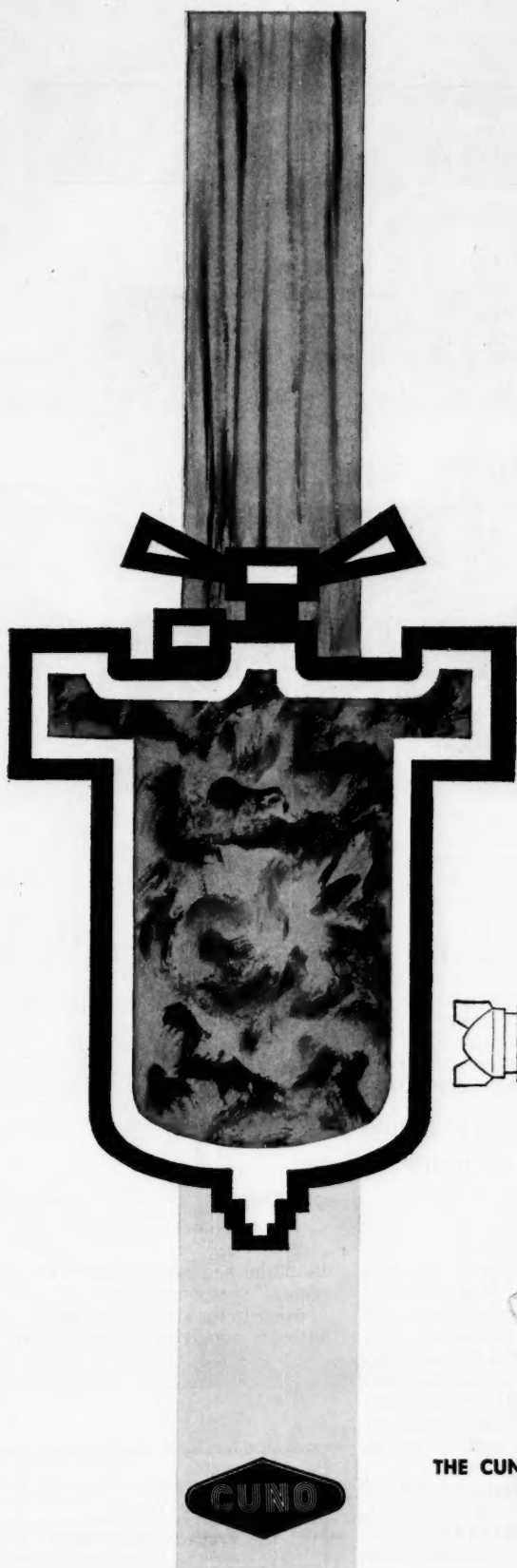
where  $X$  is  $(100 + E_B)/100$

when component B is in excess, or  $X$  is  $100/(100 + E_A)$  when component A is in excess. Here  $W_A$  and  $W_B$  are the weights in any units of components A and B;  $M_A$  and  $M_B$  are the equivalent weights of components A and B; and  $E_A$  and  $E_B$  are the percentage excesses of either A or B.

As an example, if 40 lb. of material A, having an equivalent weight of 60, is to be reacted with a 20% excess of material

B, having an equivalent weight of 80, how much B is needed?

Draw a horizontal (Step 1) through the specified weight (40 lb.) of material A to its equivalent weight 60. Connect this intersection with the "center" and extend (Step 2) to the equivalent weight 80 of material B. Move horizontally to the right scale (step 3) and then move diagonally (Step 4) through the % excess of B to 64 lb. of B.



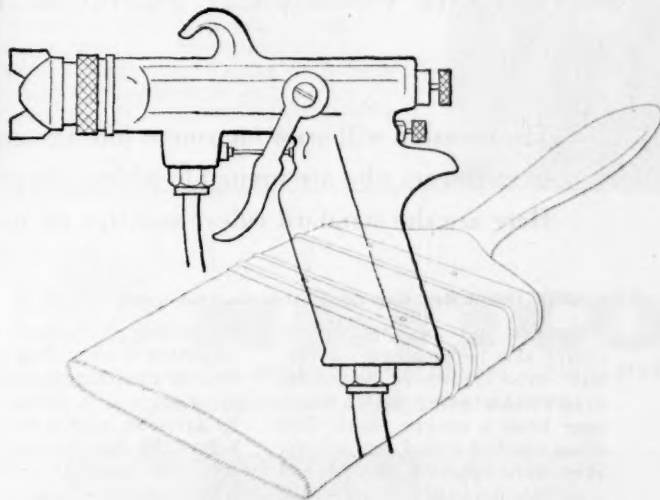
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PRACTICE ...

## YOU & YOUR JOB

EDITED BY R. F. FREMED



Wolverine Tube

# So You've Been Asked to Give a Speech

The occasion will arise for you to join the growing ranks of engineers who are invited to address large groups.

Here are the standard rules; and tips on inside strategy.

**Paul R. Heinmiller, General Electric Co., Schenectady 5, N. Y.**

Seniors in an engineering course at a northeastern university were impressed with the presentation given by an engineer from a nearby plant. But when the bell ended the session, they were appalled that he had gone through only half his slides.

Was it poor planning by the lecturer? Did he try to squeeze a 90-minute presentation into a 50-minute class period? No, he had carefully timed his remarks to 40 minutes. Then where did

his timing go wrong? He had forgotten to notify the professor that he was bringing along a set of slides and a projector. And by arriving only a few minutes before the class began, the engineer lost precious lecture time while students and professor scurried around getting an extension lead and a screen.

Nor was this omission the visiting lecturer's only oversight. Although he prepared his presentation for the specified time

limit, he neglected other fundamental responsibilities of a speaker to the sponsoring organization: supplying biographical

Next Issue

**Part II: So You're  
the Program Chairman**



Improved Processing through Engineered Agitation

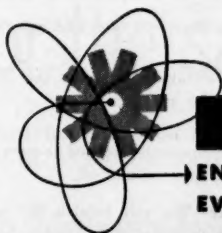
## IMPELLER SELECTION . . . THE INSIDE STORY OF GOOD MIXING

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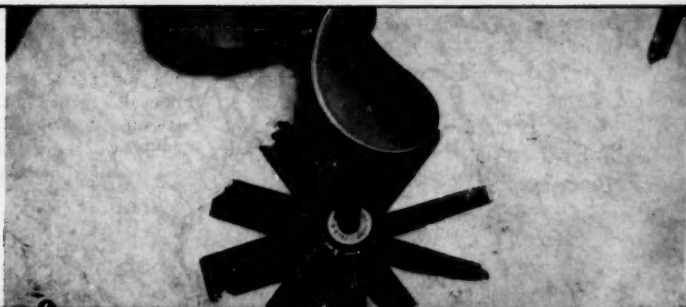
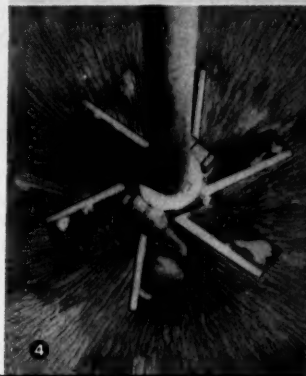
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data, photographs, news releases, and the like.

Similar incidents occur every day, seriously impairing the effectiveness of a speaker's presentation. In the eyes of the audience, they make him—and his employer—look like an amateur.

What are your obligations as a speaker toward the sponsoring organization—other than delivering a polished, stimulating presentation? After you've accepted a speaking engagement, what can you do to make your visit more successful and make the job of the program chairman easier?

This article won't tell you *how* to put together a good presentation; you can easily find such information in textbooks and other publications. But it will tell you something about the techniques used by seasoned speakers to make their speaking engagements more effective and

the task of the program chairman less arduous. A well-planned speaking engagement helps increase the prestige of both you and your employer and enhances your prospect for a return invitation.

To earn the reputation of a good speaker, check yourself on the key points outlined below.

#### Acknowledge Promptly

After you've received a request answer as soon as you can and either accept it or refuse it. If time is short, call or wire the program chairman, explaining that a covering letter will follow.

Prompt acknowledgement helps the program chairman to plan more effectively. For should you refuse, he has more time to line up another speaker or change the date to one more favorable to you.

Keep your biography current, and limit its length to one or two

pages. If it runs a full two pages, abstract it on the front page to make it easy for the person introducing you. The shorter the toastmaster's introduction, the less time you'll have to pare off your speech. Besides, the audience has already had the opportunity to read about your background on the program itself and through advance publicity.

Today you have little excuse for sending out carbon copies of poorly written, out-of-date biographies. Paper is cheap and duplicating services inexpensive. Be generous. Send your program chairman three or four copies. This isn't conceit; it's consideration. He can pass copies along to the organization's publicity chairman and the toastmaster and still keep a copy on file for himself.

#### Send Some Pictures

Send two or three copies of a current portrait of yourself along with your biography. Two different poses are best. The publicity chairman can then send a different picture to each local newspaper with a better chance of publication.

Be sure the pictures are glossy prints, 4 × 5 or 8 × 10, and suitable for newspaper reproduction. If you're a well-known, popular speaker, you may want to consider having 1-column newspaper mats made of your portrait. Editors receiving a mat are much more likely to use it than go to the expense of having an engraving made from a photograph.

#### List Mechanical Requirements

If your presentation requires a slide projector, movie projector or any other mechanical facilities, advise the program chairman promptly. List the requirements separately and send a few copies along to the program chairman.

Typical mechanical requirements for a 2 × 2 slide presentation are given in the checklist. Be sure to tell the program chairman what size slides you will use—2 × 2, or 3½ × 4 in.

Movie projectors required are usually 16 mm. (rarely 8 or 35 mm.) and specify with or without sound. Give the program chairman enough time to make

### Typical Mechanical Requirements For a 2 × 2 Slide Presentation

You can use the following checklist as a guide for your own presentations. Develop your own list and send it in advance to the program chairman of the sponsoring organization. It pays to be insistent about equipment. Too often either the speaker or the program chairman takes it for granted.

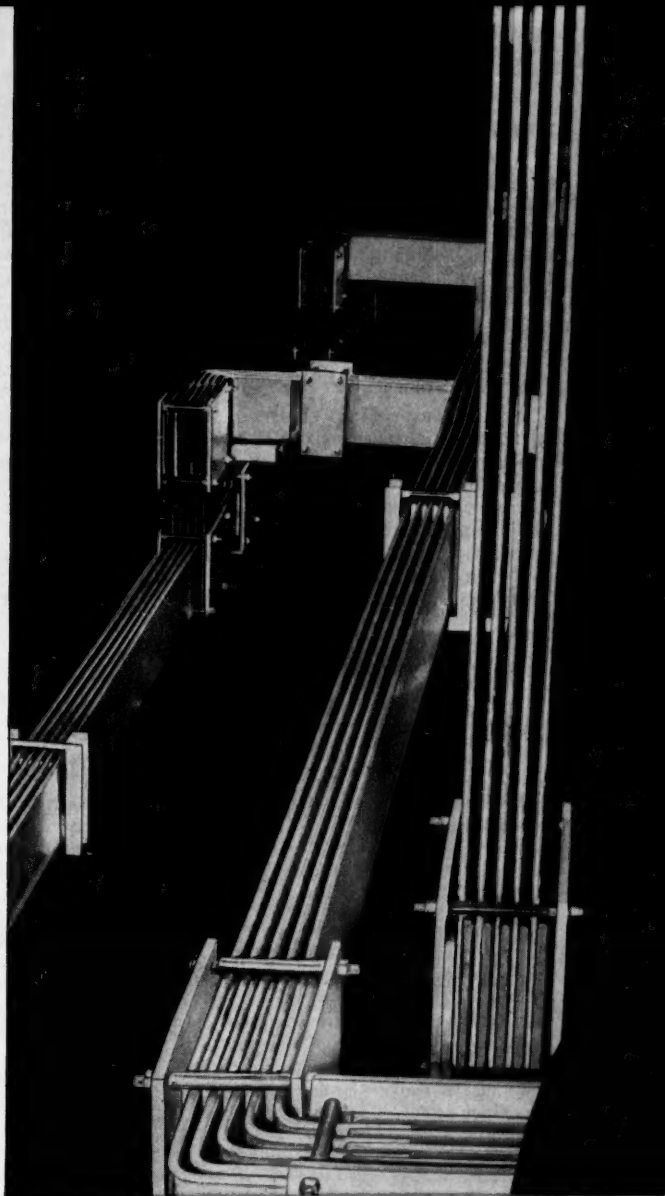
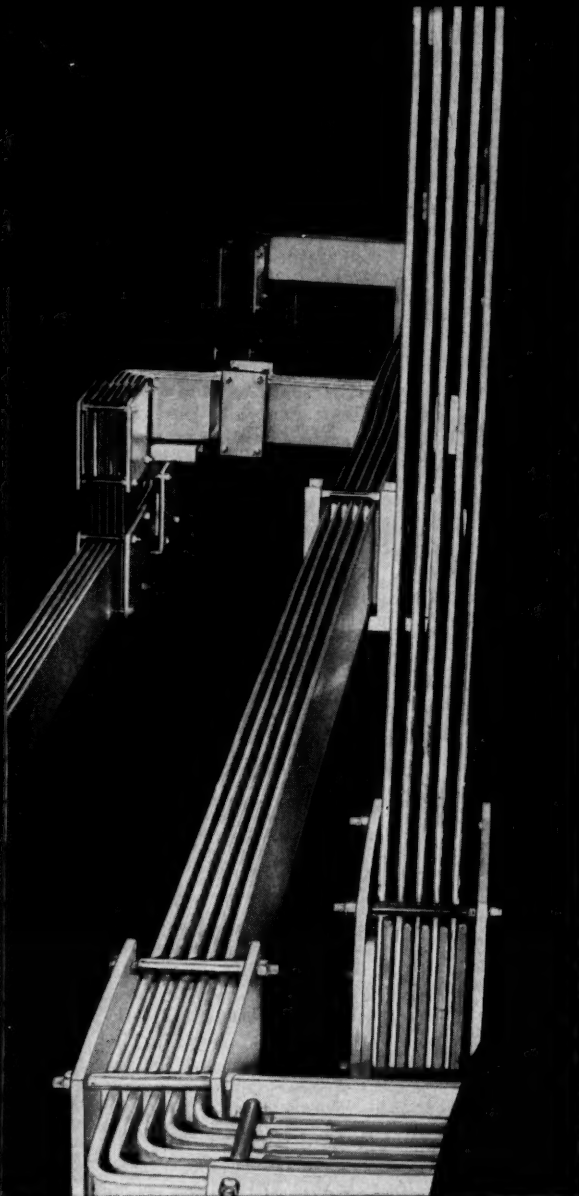
#### Facilities to Be Furnished by The Sponsoring Organization:

1. Projector to handle 2 × 2 glass-mounted color slides. About . . . . slides will be used. Projector should be of suitable wattage for room, 500 watts or more is recommended.
2. Experienced projector operator. (Union member?)
3. Steady platform for slide projector. It must be high enough to "shoot" over the heads of the audience.
4. Lighted lectern. Reading light properly shielded so it will not spill light on the screen.

5. High-grade screen of size suitable for the room's maximum viewing distance.
6. Public-address system if warranted by size of audience. Microphone should be attached to the lectern. Floor microphones are generally not satisfactory.
7. Auditorium or room that can be darkened properly.
8. Electric outlets and extension cord.
9. Drinking water at the lectern for the speaker.
10. Someone assigned to turn the room lights on and off.

*Note*—We will furnish the cueing device to signal slide changes to the projectionist if one is not available in the auditorium. In some cases we may furnish a cued script for the projectionist. We will arrive early enough to run through a portion of the presentation so that the projectionist will become familiar with the technical requirements.

For further information, write or call:



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all the arrangements and obtain the equipment. When doubtful about the quality of the slide projector that will be furnished, take your own if convenient. Further information about projectors and screens is given below.

#### Plan Your Publicity

Advise the program chairman in advance whether you will be available for radio, TV and newspaper interviews. If he knows far enough ahead, his publicity chairman can alert local communication media about the event and thus gain important publicity for the occasion.

Today, interviews by members of the press and radio often can be held directly in the lecturer's hotel room because of the portability of high-quality tape recorders. For TV you would go to the studio at a time compatible with the station's program schedule, although a station may send cameramen to get film footage of you ahead of time.

Have your news bureau or publicity department prepare a one- or two-page news release about your speaking engagement at such-and-such function. Include in the news release: who, what, why and when, as well as information about your subject.

Send a supply of these news releases to the program chairman, who will distribute them to professional society and business publications, house organs, local newspapers and radio.

Reprints of your talk, available to the audience after presentation, are valuable. If you plan to have reprints, send copies to the press along with the news releases. Also, let the program chairman know in advance about reprint availability.

If you want to undertake questions from the audience after your speech, advise the chairman. He'll plan it in the program or ask you to allow time

## What You Should Know About Projectors and Screens

Today there is no excuse for slide or movie presentations that show washed-out pictures barely discernible beyond the middle rows of the audience.

#### Pick the Right Projector

For the majority of your presentations you'll want a top-quality slide projector with a lamp of at least 500 watts. A 300-watt projector is satisfactory for the home, classroom or a small audience of 20 or 30 people. If you're speaking in a large auditorium with a few hundred people in the audience, projection equipment of the proper caliber may be furnished. No one will criticize you for having the pictures too big and too bright.

#### Portable Screens

Portable screens (on tripod legs) come in sizes from 30 x 40 to 72 x 96 in. The 60 x 60 size is about the largest you can carry comfortably in your car; larger sizes can be transported in a station wagon.

#### The Right Width

The recommended screen (picture) width of one-sixth the maximum viewing distance makes small details readily visible. A room 30-ft. long would require a 5-ft.-wide screen. Where you have no critical visual details, as in a pictorial motion picture, you can increase the ratio a little. Reduction in picture size increases brightness; a 30-in. picture will be four times brighter than a 60-in. picture with the same light on each. Always err toward the next larger screen size if you have enough light.

If the room is not well-darkened and some low-level "nonimage" light falls on the screen, you may have to settle for a smaller-than-desired picture to obtain acceptable brightness.

Reflected-light screens fall into three categories: glass beaded, processed metallic and white matte. For a description of the properties of each, see "How Lighting Serves Education in Industry," by Carl J. Allen, *G-E Review*, Sept. 1956, p. 47.

Sometimes it is difficult to raise a portable screen high enough so that the audience in the back has a clear view. Setting the screen on top of a table often will do the job if the ceiling is high enough. Another trick is to use three chairs, placing one leg of the tripod on each.

#### Watch Your Slide Mounts

Slide mounts are critical, especially if you use your slides frequently. The cardboard mounts furnished by commercial film-processing establishments aren't satisfactory for hard use. They allow the transparency to become scratched, and the cardboard is subject to warpage and fraying. Furthermore, in such mounts, the transparency tends to "pop" out of focus as it heats.

Use metal mounts, or mount the slide between glass covers and bind with professional binding tape. And keep your bindings neat. Loose and frayed bindings can jam a projector and ruin your presentation. Don't mix cardboard mounts and metal or glass mounts, because the projector must be focused each time to compensate for the differ-

ent type of slide mount in the holder.

#### To Signal for a Change

How do you signal a slide change? The hand-operated "cricket" or "Next slide please" disturbs the smooth continuity of a polished presentation. Instead, use either an automatic projector so that you can control slide changes yourself, or arrange a simple cueing device that flashes a light at the projector when you press a button. Or have someone at the projector cue the projectionist from a copy of your script.

Unless union regulations prevent it, why not use your own projectionist?

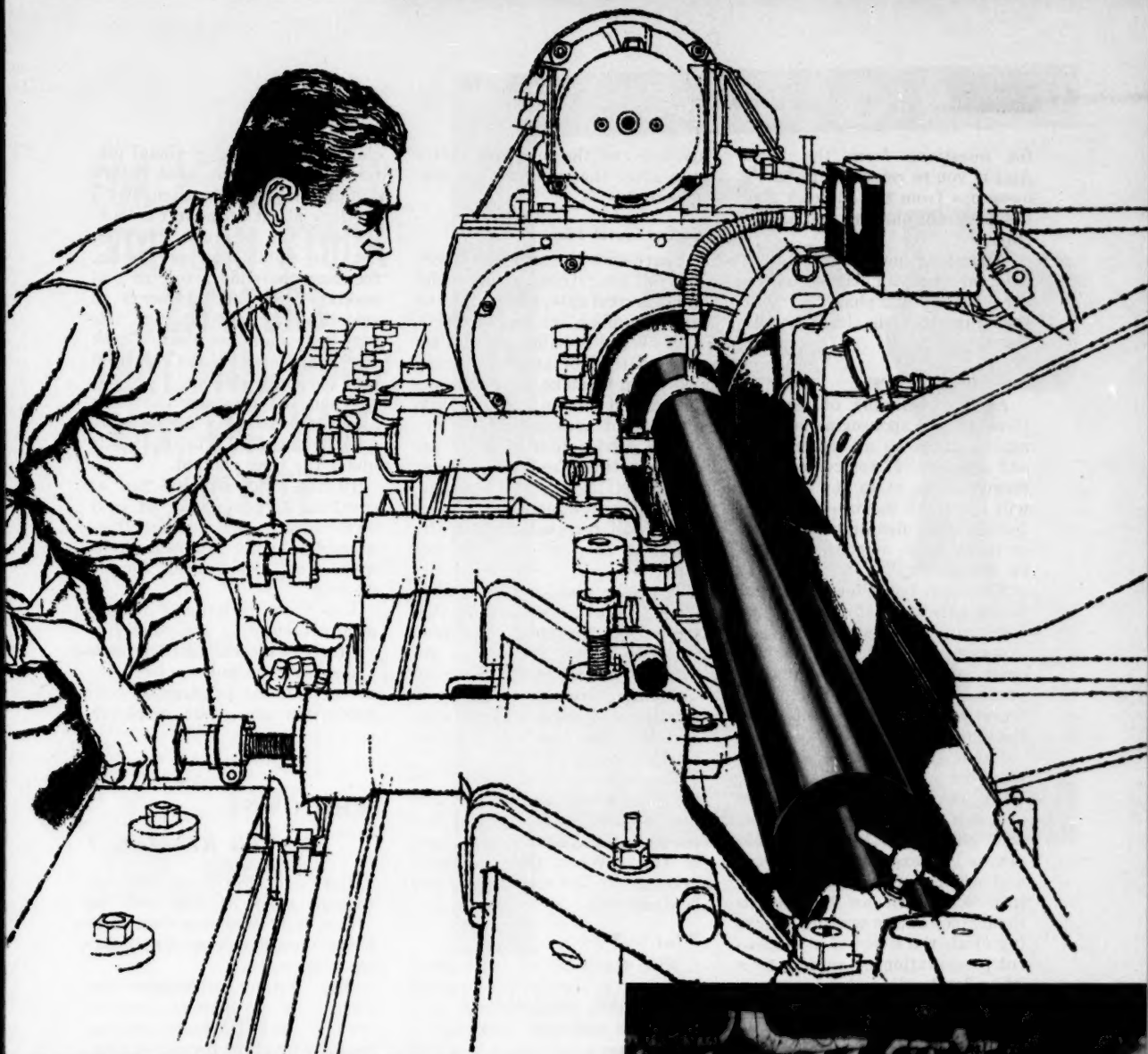
#### Don't Watch the Show

Don't look at screen. Don't say "In this slide," or call attention to the mechanics of the presentation.

#### Proper Picture Size

Sometimes it is necessary to place the projector in the midst of the audience to achieve the desirable picture size, or to keep the picture from bleeding off the edges of the screen. This is not good practice although sometimes it is unavoidable when only one lens is available for the projector.

To maintain proper picture size and at the same time move the projector further away from the screen, use a lens of longer focal length. Lenses of several different focal lengths are available for most high-quality projectors, both slide and movie. With picture size constant, focal length and "throw" vary in direct proportion; that is, if you double focal length you can double the projection distance.



## PROFIT INSURANCE with J&L Stainless Steel Bars

Your machining costs on stainless steel bars are part of your investment for profit. Add your costs for tooling, handling and polishing, and you multiply your investment, often many times over.

Scrapping a single bar wipes out that investment—and with it most of your profit on a large volume of finished goods.

Every step taken to reduce rejects helps insure profits! The biggest step you can take in that direction is to specify J&L Consistent Quality on all orders for stainless steel.

J&L leads the industry in melt shop standards for stainless steel—the point where quality starts, and your profit insurance begins.



Careful attention to every production detail is the key to J&L quality



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**STAINLESS**  
SHEET • STRIP • BAR • WIRE

for questions from the floor. And if you're reluctant to tackle questions from the audience, tell the program chairman ahead of time.

Answering questions from the floor can be a stimulating experience, but it's one phase of public speaking that is loaded with traps.

#### Settle on Expenses

At the beginning of negotiations with a sponsoring organization, agree on an honorarium and expenses. If you customarily receive a fee, state how much it will be. If an honorarium is offered, either definitely accept it or mention an amount that will be acceptable.

The same holds for travel and living expenses. If you or your company expect to absorb such expenses, advise the program chairman. If the sponsoring organization is expected to cover travel and living expenses, settle the matter early.

Usual expenses covered for a speaking engagement are first-class, round-trip transportation plus meals, hotel accommodations and gratuities. Define the expenses you expect to be covered and when you will submit your invoice. Agree on the details in advance and in writing. Nothing chills the effect of a successful presentation as rapidly as a misunderstanding about honorariums and expenses between the

speaker and the program chairman after the audience has disappeared.

#### Advise Travel Plans

Share with the program chairman all your transportation details: arrival date, time, flight or train number, airline or railroad. When driving, give an estimated time of arrival. If you want him to make a hotel reservation, tell him so and give him the type of accommodations desired. Advise him of your departure time and any other travel details you think important. If you want him to make any travel reservations, let him know as soon as you possibly can.

If you're speaking at a club, college or auditorium some distance from the hotel, determine in advance how you are to get there. The program chairman will either arrange to have you picked up by private car or suggest that you take a taxi to the meeting place.

If you're driving directly to the place where you'll speak, and you're uncertain of its location, request a marked city map ahead of time. When time is short, getting lost in a strange city can be disastrous.

#### What to Wear

Nine times out of ten a business suit is appropriate to wear for speaking engagements. But the tenth occasion—standing at the speaker's table in a business suit when everyone else is wearing a dinner jacket—can be embarrassing. Get the matter of suitable dress settled ahead of time.

If it's an event where wives are invited, take yours along. She'll enjoy the trip and feel mighty proud of her husband's speaking ability. Even though the event doesn't include wives, take yours along anyway if it's convenient. The trip and hotel living may be a treat, and she may welcome a brief vacation from the children.

#### Allow Plenty of Time

For an evening engagement, plan to arrive in the afternoon; if it's an afternoon presentation, why not get there before lunch? This is of vital importance, espe-

cially when you have visual material to set up or need to try out the projection equipment.

Allow about an hour for looking over the facilities, checking out the public-address system, focusing the slide projector and making other arrangements to smooth your presentation. Be sure your slides are clean. Check the sequence and make sure that they are right side up.

When the program chairman asked you to speak for 40 minutes, he meant it. Finish slightly under the time allotted.

Itemize your expenses just as carefully as you would for your own company. Then submit them promptly to the program chairman. Don't let it drag for six weeks.

Use these techniques with a good presentation and you'll find yourself in increasing demand as a speaker—to the benefit of your career and the prestige of your profession and your employer.

## WHO OWNS

### . . . This Knowledge?

Here's a follow-up for our feature story of last year on "Does Your Employer Own Your Knowledge?" (*Chem. Eng.*, July 28, 1958, p. 127).

The National Semiconductor Corp., an electronics concern formed in Danbury, Conn., recently by eight former employees of the Sperry-Rand Corp. of New Haven, has denied Sperry-Rand's charge that they had taken documents and secrets from their former employer.

Sperry-Rand has filed a \$1-million damage suit against National Semiconductor in the U. S. District Court at New Haven. The complaint asks for injunctions and monetary damages.

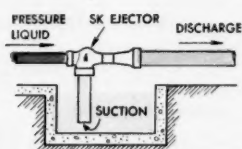
In denying the charges National Semiconductors' president, B. J. Rothlein, said that the eight men had had considerable experience in other semiconductor companies before their employment by Sperry-Rand.

"In fact," said Rothlein, "these individuals brought with them to Sperry many of the very techniques that they are now being accused of stealing."

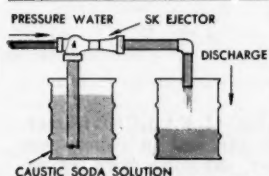


PAUL R. HEINMILLER is now engaged in a study of technical communications for General Electric's general engineering laboratory in Schenectady. A mechanical engineering graduate of Case Institute, he has served as managing editor, and more recently editor-in-chief, of the *General Electric Review*.

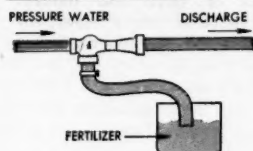
# FOR \$50.60 EACH\* YOU CAN STOCK EJECTORS THAT WILL PUMP, MIX, EVACUATE, AGITATE



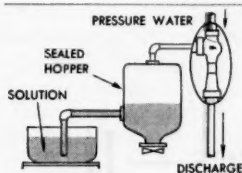
Pumping  
out a sump<sup>1</sup>



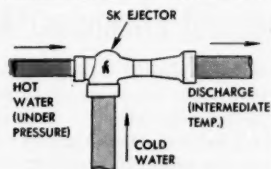
Diluting  
caustic



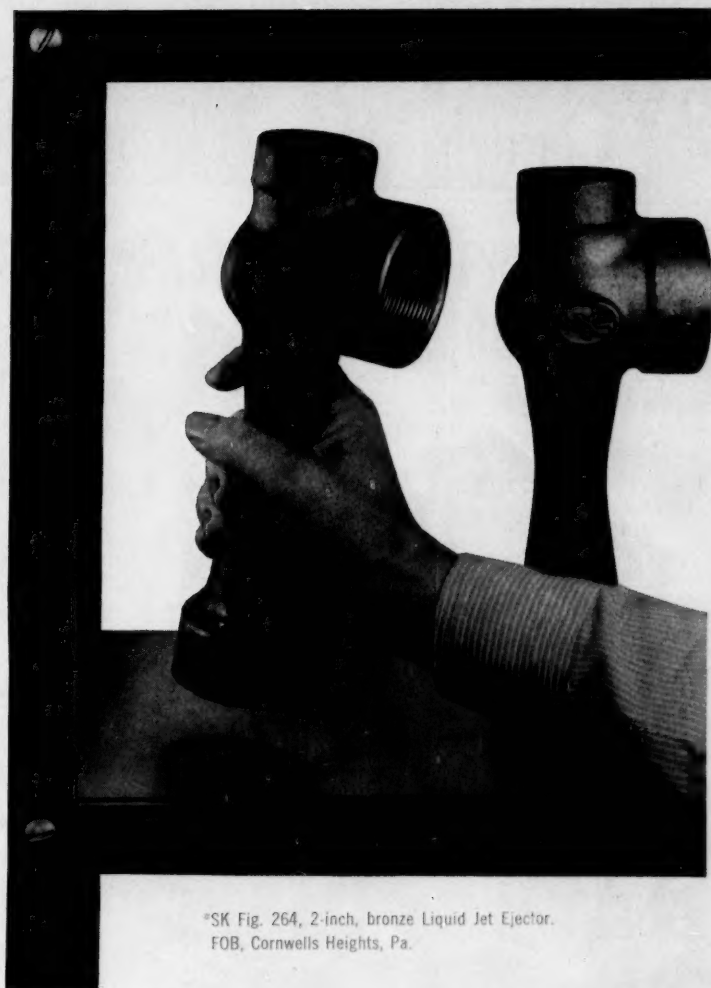
Handling  
slurry



Evacuating  
air  
(vacuum  
lift)



Heating  
cold water



\*SK Fig. 264, 2-inch, bronze Liquid Jet Ejector.  
FOB, Cornwells Heights, Pa.

Want to pump out a sump . . . mix two liquids, or a liquid and a solid . . . handle a slurry . . . prime a pump . . . agitate a solution? Low cost, uncomplicated SK Liquid Jet Ejectors are ideal for any of these jobs. That's why thousands of companies (like yours) keep several *always* in stock. Liquid Jet Ejectors utilize the kinetic energy of a pressure liquid to pump, mix and agitate other liquids, handle slurries and fine solids, and evacuate air. They are stocked in cast iron, bronze, 316 stainless steel, pvc, Haveg, and PYREX brand tubing, for quick delivery. The sketches will give you a few ideas on how you might use a stock ejector. For complete details on types, sizes, capacities, write for Bulletin 2M.



For immediate delivery, standard SK Jet Ejectors, Rotameters, and Flow Indicators are stocked in Cornwells Heights (Phila.), Pa., Houston, Texas, and San Francisco, Calif.

JET APPARATUS: Ask for Condensed Bulletin J-1.

ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.

VALVES: Ask for Condensed Bulletin V-1.

HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.

GEAR PUMPS: Ask for Condensed Bulletin G-1.



## Schutte and Koerting

COMPANY

MANUFACTURING ENGINEERS SINCE 1876

2217 State Road, Cornwells Heights, Bucks County, Pa.



**MECHANICAL FAILURE** of moving parts can lead to a disastrous emergency shutdown with an ensuing loss of time and money. Proper inspection turns emergencies into planned procedures.

## Startup and Shutdown Procedures—II

Continuing our series, here's how you should go about the actual shutdown of a process unit—planned or otherwise.

**C. A. HANSEN, Sr. Supervising Engineer, Technical Div., Humble Oil and Refining Co., Baytown, Tex.**

**T**AKING a unit off the line can be just as much of a headache as starting one up. In the last issue (*Chem Eng.*, Aug. 24, 1959, p. 154) we covered the detailed procedures for startup.

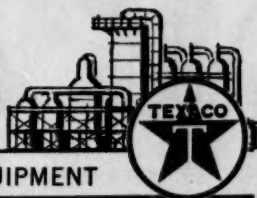
Now we'll see how shutdown enters into the picture.

Normal shutdown procedures are usually just about the reverse of startup procedures. One of your main considerations here

is avoiding too rapid a change in conditions. This prevents equipment damage by overstressing and the like.

Equipment must be cleared adequately the first time to per-

# Lubrication News



PROFITABLE IDEAS ON THE LUBRICATION OF CHEMICAL PROCESS EQUIPMENT

## Deposit analysis can uncover surprising reasons for failure

When equipment fails, industry's natural tendency is to blame the lubricant. For this reason, samples of oils and greases—often no more than mere specks—sections of failed gears, ruined bearings and other pieces of equipment are analyzed at the Texaco Research Center, Beacon, N. Y. Here they are subjected to a searching analysis by technical service experts using a tremendous catalog of apparatus and procedures.

### Lubricant is seldom guilty

Of the numerous samples submitted every year, the lubricant is guilty in less than 1% of the cases. Take a typical example:

A customer submitted a severely corroded roller bearing. The bearing and its lubricant were liberally contaminated with both red and black material. X-ray diffraction analysis disclosed that the contaminant was an alpha ferric oxide which is characteristic of fretting corrosion—usually correctable only by a design change. Had ordinary rusting occurred the contaminant would have been hydrated ferric oxide—and a finger could have been pointed at the lubricant for allowing water to come in contact with the bearing.

The March 1958 issue of *Lubrication Magazine* contains a fascinating series of these "detective stories." Write for your copy—the supply is limited.

## Attachments lengthen life of air-powered equipment

Moisture and insufficient lubrication are major causes of parts wear in air-powered tools and mechanisms. Yet, two simple attachments for the air line, plus one precaution, can eliminate these causes of wear completely.

1) Insufficient lubrication can be overcome with an air line lubricator, which sprays lubricant into the line. The air carries this atomized oil to the tool or mechanism, where it lubricates internal parts thoroughly.

2) Moisture in the air line can be

## NEW GREASE WITH EP PROPERTIES TAKES 400-700°F. TEMPERATURES

In three years of field testing, a new grease called Thermatex EP 1 has:

—lubricated equipment in which temperatures reached 700° F.

—effectively lubricated equipment handling corrosive chemicals.

—resisted coking and solidifying in steam joints, where temperatures reach 400°. In this application, steam is present, and the grease is pumped through 35 feet of  $\frac{3}{8}$ " tubing.

In these steam joint tests, previous failures of the automatic pumping unit and of the steam joint had resulted when grease solidified and coked in the last foot of the line. These failures occurred as often as every two weeks. During a two-year test with Thermatex EP 1, no failures whatsoever occurred due to lubrication, and no evidence of

coking or plugging was recorded. Several joints were operated for more than 9 months with no need for maintenance.

### Characteristics and properties

Thermatex EP 1 is a high temperature grease of No. 1 NLGI consistency containing EP additives. It has good heat stability (dropping point: over 500° F.), good shear stability, excellent water resistance, and good wear characteristics. It provides excellent lubrication, and will not separate or harden excessively under pressure.

Information now available shows that Thermatex EP 1 will lubricate satisfactorily at 450-500° F., when re-lubrication occurs every 3 or 4 days. It will provide adequate lubrication at 550° F., with more frequent lubrication periods. While useful lubricant life at temperatures above 550° F. is measured in hours, use of centralized pressure systems should insure completely adequate lubrication.

For complete information and additional test results, check the coupon.

### Guide to Organized Lubrication

Organized lubrication, as a means of controlling costs, is discussed from management's point of view in this important booklet. It describes methods that help raise production, extend parts life, cut downtime.

For free copy, use coupon below.



Thermatex has been tested successfully as seal and lubricant for packing-type bearings in mixing machines, similar to these, which handle corrosive alkalis and acids at temperatures to 275° F.

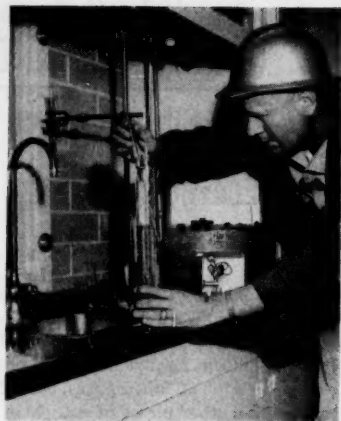
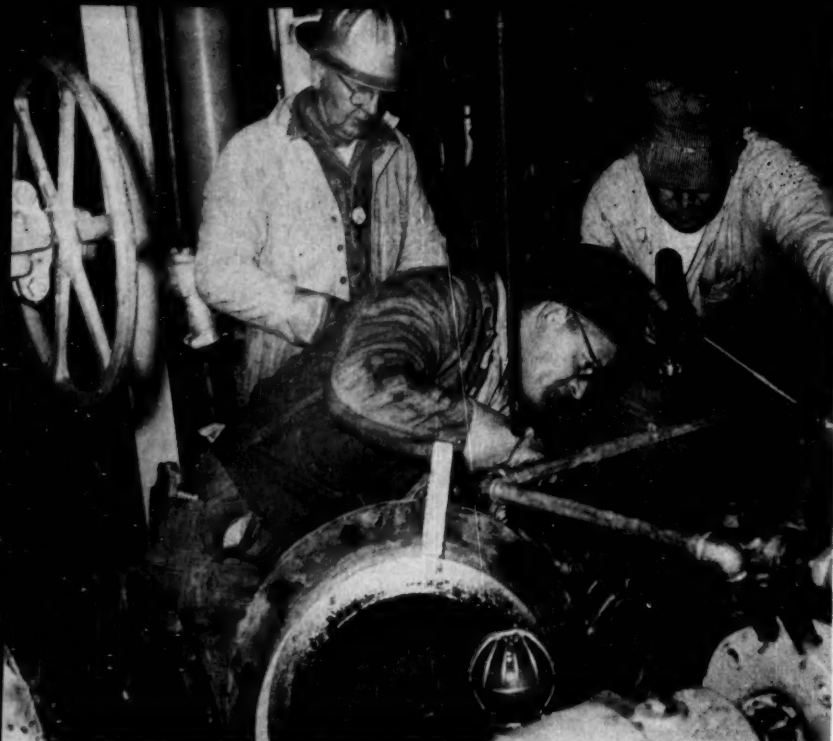
TEXACO INC.  
Dept. CE-CP-30  
135 East 42nd Street  
New York 17, N. Y.

I am attaching my company letterhead to this coupon.

- ☐ Send a copy of "Management Practices that Control Costs via Organized Lubrication."
- ☐ Send information on Thermatex.
- ☐ Send information on Worm Gear Lubricants.
- ☐ Send information on Air Tool Lubricants.
- ☐ Ask a Texaco Lubrication Engineer to call at my plant.

Name \_\_\_\_\_

Title \_\_\_\_\_



**BEFORE** opening and entering any equipment, make tests to be sure all toxic and flammable materials have been removed and the area safely cleared for work.

mit entering vessels and performing hot work without delay. Make provisions to insure that the equipment is kept free of flammable or toxic materials.

A checkoff list of battery limit "must" blinds and optional individual vessel blinds is very helpful to operators in carrying out this assignment. This same list is very useful for checking removal of all blinds before startup.

#### **Emergencies Mean Watch Out**

Emergency shutdown procedures present an entirely different problem. An unsafe condition has developed in this case and time is of utmost importance in restoring the unit to a safe condition.

Usually various combinations of special facilities such as motor operated valves, safeties, spray water systems, fire water systems, blowdown systems and torch systems are needed to adequately cope with an emergency situation.

Necessity for all or part of such facilities is a matter of judgment based on the process itself and previous experience.

Such equipment doesn't normally serve any useful or productive purpose making it desirable from an economic standpoint to provide only that

which is absolutely required for a reasonable degree of personnel safety and equipment protection.

#### **Don't Compound Emergencies**

One approach helpful in arriving at a good answer is the concept of a "single risk." In other words, don't compound emergencies. Provide for only one mistake or one failure at a time.

The odds are high that more than one occurrence will not happen at a time. This approach should not confuse the issue as to what the possible consequences to a particular circumstance might be.

A list of normal emergencies or failures that are likely to occur on any unit is a starting point. This includes such things as the loss of a utility such as electricity, fuel, instrument air or cooling, failures of various pumps or compressors, leaks or line breaks and furnace tube failures.

Evaluate the likelihood of occurrence of each of the items listed on the basis of previous experience and knowledge of the new process.

Many times, special problems are added due to the nature of the process itself. This encompasses such things as afterburning, loss of catalyst circulation,

or low and high reactor temperatures in a fluid catalyst cracking unit; another example is the problem of stopping or controlling exothermic reactions due to hydrocracking or catalyst base change in a hydroforming unit. Carefully evaluate your list and provide special equipment to cope with the situations deemed serious enough to warrant it.

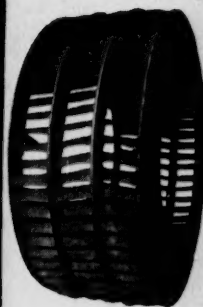
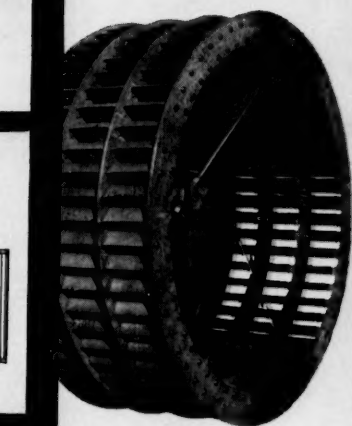
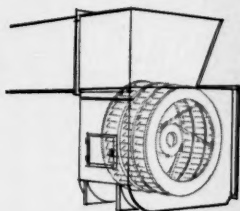
Make a review of normal shutdown procedures. Often special emergency equipment can be used profitably to expedite normal procedures.

Make provisions in the original design of emergency equipment that permit checking these facilities for proper operation during normal operations. This is very important since these facilities are used infrequently and without periodic inspection and operation, they might not function properly during real emergencies.

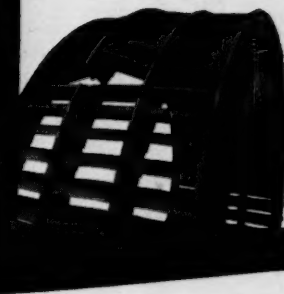
#### **Work and Effort**

In summary, you can establish good startup and shutdown procedures for a reasonable cost on equipment which handle all but the most unusual or compounded situations. You can't attain or maintain this goal without considerable work and effort on the part of management.

New steels are  
born at  
Armco



2



Typical fan unit, made of Armco 17-14 Cu Mo Stainless, has given ten years of unfailing service at high temperatures. Rims, buckets, tie rods and rivets are all 17-14 Cu Mo stainless. Photos 1 and 2 show the type of failures encountered with Type 316.

## TEN-YEAR RECORD PROVES ECONOMY OF ARMCO 17-14 Cu Mo STAINLESS FOR HIGH TEMPERATURE, HIGH STRESS SERVICE

Fan units like these are used to circulate hot gases in the catalytic unit of a butadiene plant. Operating temperatures range from 1000 to 1250 F; rotational speeds up to 600 rpm create high hoop stresses. Because it was the best available material at the time, Type 316 stainless formerly was used for the fans. However, the fans failed from creep under the combination of high stresses and heat. The kind of failure encountered is illustrated in photographs 1 and 2.

Ten years ago a new stainless steel, Armco 17-14 Cu Mo, was used for replacement of failed fans. These units have been giving satisfactory service since that time. Careful checks were made of their performance. As a result, all fans now are made of 17-14 Cu Mo Stain-

less steel, including those for a recent plant expansion.

### Excellent High Temperature Properties

Outstanding features of Armco 17-14 Cu Mo Stainless are its high creep strength, long-time rupture strength, resistance to relaxation, and good resistance to corrosion and oxidation. It is unusually economical for applications up to 1500 F. Added advantages of this special Armco Stainless Steel are its excellent workability in both hot and cold condition and its availability in sheets, plates, bars, wire and forging billets.

For complete information on the properties and fabrication of Armco 17-14 Cu Mo stainless, write Armco Steel Corporation, 2989 Curtis Street, Middletown, Ohio.

## ARMCO STEEL



Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation

PRACTICE ...

## CORROSION FORUM

EDITED BY R. B. NORDEN



For low-cost patching and maintenance coatings ...

## Now Isophthalics Challenge Epoxies

With chemical resistance about the same as epoxies, Oronite's new isophthalic-based materials are much lower in cost, are less toxic and are easier to apply.

Some people call them low-cost epoxies—which is technically incorrect. But it's a fairly good description of Oronite's new chemical-resistant isopolyester maintenance compounds, causing a big stir in chemical-engineering circles.

These polyesters are based on isophthalic acid—hence the name isopolyesters. Not new to the plastic industry, isophthalic acid

is used in alkyd-resin formulations for house paints, and in plasticizers and plastic compositions where it has some superiority over phthalic anhydride (see *Chem. Eng.*, Mar. 1956, p. 142).


Armed with new resins and newly developed formulations, Oronite now hopes to crack the big process corrosion market in three areas:

- Patching compounds for quick repair of corroded equipment, without greatly disrupting plant operations. (No welding required; equipment doesn't have to be hauled to a safe area.)

- Glass-isopolyester laminates for repair or coating of large sections of equipment.

- Maintenance coatings (outside and inside equipment).

► Competes With Epoxies—Gen-



*DURCO TYPE F VALVES have been in service for more than 3 years at KETONA CHEMICAL CORP., Ketona, Alabama, handling 83% ammonium nitrate at 250° F.*

These non-sticking, non-lubricated, Durco Type F valves with Teflon sleeves have provided dependable service with almost no maintenance cost. The valves illustrated are of Durimet 20. Durco Type F valves are available from 1/4" thru 4" in nine standard corrosion resisting alloys. For complete details, ask for Bulletin V/4b.





### For Large-Scale Repairs, Spray Plastic-Glass

In a unique large-scale application, the corroded bottom section of a 10-ft.-high by 60-ft.-dia. storage tank was covered with isopolyester laminate. Total covered area: 3,200 sq. ft. Technique calls for a five-man crew. Two men spray resin-glass mixture, two roll the material, one checks resin and glass supply. Double-headed spray guns and attached glass chopper are basic for proper coverage. Total cost/sq. ft. is \$1.05. Sheet metal would have cost \$3-4/sq. ft.

#### Costs to Repair Tank Bottom

	Man-Hours	Cost of Operation, \$/Sq.Ft.		
		Labor	Material	Total
Hauling and rigging	12	0.02		0.02
Sandblasting	51	0.09	0.03	0.12
Cleaning up sand	16	0.04		0.04
Prime resin coat (1:1 isopolyester)	18	0.03	0.06	0.09
Coat seams with Cab-o-sil mixed with isopolyester	34	0.04	0.05	0.09
Spray resin and glass roving	88	0.15	0.46	0.61
Finish coat of wax-containing isopolyester	18	0.03	0.04	0.07
Styrene, dimethyl aniline, methyl ethyl ketone peroxide, benzoyl peroxide, cobalt naph- thenate			0.01	0.01
Totals	237	0.40	0.65	1.05

erally, these new isopolyester-based materials are handled very much like epoxies. But isopolyesters have some big selling points. They cost less than epoxies and are not toxic or difficult to handle (epoxies call for skin-irritating, amine-hardening agents; peroxides set isopolyesters). Also they have excellent adhesion and flexibility.

At the same time, isopolyesters share a basic disadvantage with epoxies: You have to work with a "two-pot" system—a catalyst and a resin.

A typical formulation consists of 1 mole isophthalic acid, 1 mole maleic anhydride, 2.1 moles propylene glycol. The ester from

this combination is dissolved in styrene and the mixture cured at the time of application with peroxide catalysts (benzoyl and methyl ethyl ketone) and a promoter to speed up reaction at room temperature (cobalt naphthenate or dimethyl aniline). Curing involves a polymerization reaction between styrene and the unsaturated ester.

Formulations can be varied in two ways. Going from a monoglycol to a long-chain diglycol will produce a more flexible product. Or you can increase ratio of isophthalic to maleic to get flexibility.

► **Plant Tested**—Not just laboratory babies, the new ma-

terials have been extensively plant-tested at Standard Oil of California's Richmond refinery (a joint program with the refinery engineering group, the Richmond materials laboratory and California Research Corp.). Oronite is a subsidiary of Socal and marketer of isophthalic.\*

A big factor behind the plant test program: availability of new dual spray guns capable of handling catalyzed resin systems.

Many a Socal engineer has grinned with delight at the program results. Corrosion and maintenance costs are down sharply.

► **Patching Came First**—Plastic patching compounds (flexible formulations) were the first materials worked on at Richmond, Calif.

There are, of course, competitors in this field. Epoxies are widely used (*Chem. Eng.*, Jan. 27, 1958, p. 148) as are plastic metals (*Chem. Eng.*, Nov. 3, 1958, p. 150).

Very roughly, isopolyester-patching compounds cost about \$0.35/lb., epoxies \$0.70/lb., not including glass cloth; plastic metals are in the \$2-\$3/lb. and up range.

As with epoxies, the isopolyesters are used with strength-giving glass fibers.†

Laminate acid resistance (conc.  $H_2PO_4$ , 50%  $H_2SO_4$ , 30%  $HNO_3$ ) is excellent. Alkali resistance is not as good although isopolyesters can be formulated capable of handling strong alkalis—at some sacrifice in strength properties.

Usual temperature limitations for laminate patches are 180 F. for continuous service; 250 F. for short exposure.

A typical pipe repair: corroded area is first dried, sandblasted or wire brushed. The hole is filled with catalyzed isopolyester containing short glass fibers. A piece of 4-in. glass tape, soaked in catalyzed isopolyester, goes over the patch, and is coated with isopolyester. The resin com-

\*Oronite has prepared a report on this work. The report is endorsed for use by subsidiary operating companies by the Board of Engineers, Standard Oil of Calif.

†Suppliers of patching compounds: Fiber Glass Evercoat Co., Blue Ash Road, Cincinnati 36, Ohio, and Taylor and Art, 1710 E. 12th St., Oakland, Calif.



EXPANSION JOINTS



## How to keep your cost accountant contented

Just ask him to amortize the cost of a U.S. Rubber Expansion Joint.

He will have a pleasant time discovering that these joints never seem to wear out. Some have been in use for 30 years and are as sturdy as ever. No other rubber expansion joints have been in use that long.

"U.S." Expansion Joints are the only joints that have withstood this test of time. As for value, "U.S." Expansion Joints remain the cost accountant's delight. Other so-called "just-as-good" joints costing a few dollars less can rob you of many times their complete cost when they cause downtime.

Your accountant will tell you that "U.S." Expansion Joints comprise shrewd, logical insurance. These joints are the economical, flexible connections used in all kinds of pipe lines to take care of misalignment, vibration, expansion, contraction and noise transmission. No moving parts to wear or bind; can be installed on new or old equipment.

• • •

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Mechanical Goods Division

# United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y.

In Canada: Dominion Rubber Company, Ltd.

pletely cures in about 6 hr. at room temperature.

How much pressure the laminate can take depends on extent of the corroded area. It's usually recommended that a patch extend at least 2-in. beyond the leak. Such patches can take internal pipe pressures of 50-100 psi. and above.

► **Big Savings**—Using this technique, Socal engineers have repaired three corroded and eroded wax deoiler tubes operating at 140 F. It would have cost over \$8,000 to replace these tubes. Repair costs were considerably below this figure and the tubes have been operating for over a year without difficulty.

An extreme example: a salt-water return pipe section (on a line feeding three plants) developed a leak at a joint. Salt water gushed out of a 4 x 1½-in. hole.

To repair this, a short redwood plug was driven into the hole to cut water flow. Isopolyester putty, mixed with a fairly high concentration of catalyst to obtain a fast cure, was applied around and over the plug and held in place until it set, stopping the leak. Adjoining area was dried, wire brushed and several layers of isopolyester-impregnated glass cloth wound over the patch and around the joint. Water pressure was not reduced during the entire repair operation.

Total cost of labor and material: \$150. To shut down the three plants for three days and replace the section would have involved \$12,000 of downtime costs.

► **Large-Scale Repairs**—Refinery engineers have also used this reinforced-plastic technique on very large metal surfaces, such as tank bottoms. This is something more than mere patching. Cost savings, when compared to repair with steel plate, are considerable.

On a job involving a 60-ft.-dia. by 10-ft.-high vessel, Socal covered the corroded tank bottom and part of the side walls with a isopolyester glass-reinforced laminate at a cost of about \$1/sq. ft. (see table). This cost will come down with more experience and improved equipment. A new steel plate bottom would cost between \$3-\$4/sq. ft.

This doesn't include downtime—between 10-20 days for plastic repair, 30-90 days for metal.

► **How It's Done**—The picture on p. 176 shows the technique used—dual spray guns (one feeds catalyzed resin, the other promoted resin) and a glass chopper.

First bottom and sides are sandblasted. Then to avoid overnight rusting, a 3 to 4-mil coat of clear isopolyester goes on.

You fill all holes with a thixotropic isopolyester (2-9% silica gel), and apply it over rivet holes and along seams.

A crew of five men then sprays glass laminate (25% glass) in place—chopped rovings (1½-in. lengths) and isopolyester. Two men spray, two men roll the sprayed material for compacting and air removal, and one man checks to make sure there is an adequate supply of glass and resin.

Then a thin layer of wax-containing isopolyester goes over the entire bottom to make sure no uncoated glass sticks out from the laminate. Wax assures fast cure and immediate water resistance. However, chopped-glass laminates are not as strong as laminates made with long glass fibers.

► **Resistant Coatings**—Not overlooking any possible maintenance applications, Socal has also investigated corrosion-resistant paints made with isopolyesters. Here, again, they are used very much as the epoxies. Costs are about \$6/gal. (compared with \$10/gal. for epoxies, \$7.50-\$12 for urethanes).

Styrene in the formula doubles as a viscosity reducer—there is no volatile solvent.

Basically a coating system consists of 100 parts isopolyester-styrene, 1 part catalyst (benzoyl peroxide), 0.3 parts promoter.\*

With a double-barreled spray gun, coatings of 6-8 mils can be applied in one or more passes on sandblasted surfaces. Catalyzed resin (working life, three days) atomizes through one barrel, promoted resin (working life, four months) through the other.

\*Coating suppliers include such names as Glidden, Pittsburgh Plate Glass, Cook Paint and Varnish, Reichold, American Cyanamid, Archer-Daniels-Midland, Chemical Process Co.

Resin streams meet before hitting the surface. Working life of the mixture is ½ to 1 hr. and cure is complete in about 6 hr.

For rapid cure, a small amount of wax is added to the isopolyester before spraying. Only the final coat contains wax. (Oronite is working on non-air-inhibited isopolymers to avoid the wax step.)

Also work is going on in the area of pigmented coatings—which will increase outside durability. So far, such coatings show excellent gloss.

► **Need Better Equipment**—The clear coating can be brush applied. But working life of the mixture of catalyzed resin and promoted resin is too short for big jobs (without the promoter, setting times would be too long). This is the reason so much work has gone into development of spray guns.

Actually, for unreinforced coatings, several guns available on the market have been used for isopolyesters (see *Mod. Plastics*, May 1959, p. 89).

One is the Peterson gun (Peterson Spray Gun Co., 1751 Leslie St., San Mateo, Calif.). Another is the Sealzit gun (Sealzit Co. of Amer., 3460 Chicago Ave., Riverside, Calif.)

But spraying glass and resin is not so simple. The two resin mixes must meet as they emerge from the gun, then contact and thoroughly coat the glass, all before striking the tank bottom. You don't want a lot of uncoated chopped-glass fibers floating around, and you need a fairly high glass content in the laminate for strength.

Socal is using a moving platform and a trailer. The moving platform holds a supply of glass fibers, which get to the chopper via telescopic booms. The trailer contains catalyzed and promoted isopolyester.

There is no fog or mist, commonly found in most spray jobs. This is because the guns developed for sprayup don't give extreme atomization.

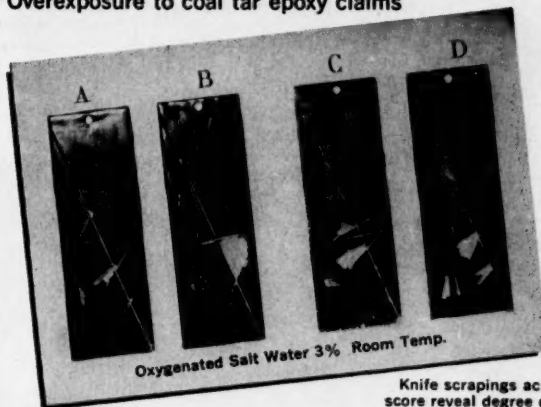
But improvements in spray equipment are needed. Socal uses the Sealzit or Peterson gun and chopper, but feels no commercial gun is completely satisfactory for long hours of continuous application.



## SUFFERING FROM

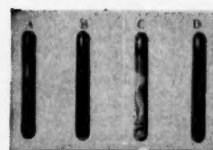
## COALTAREPOXICATION?\*

\*Overexposure to coal tar epoxy claims

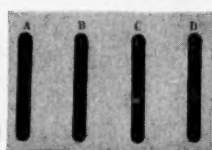


Oxygenated Salt Water 3% Room Temp.

Knife scrapings across diagonal score reveal degree of undercutting.



Sodium Hypochlorite 5% Room Temp.



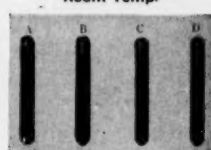
Aviation Gas 100/130 Octane Room Temp.



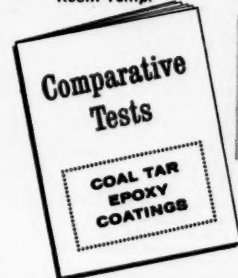
Salt Spray (scored panels) Room Temp.



Sulfuric Acid 10% Room Temp.



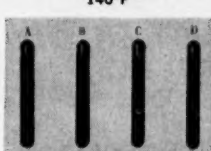
Sulfuric Acid 30% Room Temp.



Sodium Chloride 20% Boiling



Sour Crude 120°F



JP-4 Jet Fuel 120°F



Aromatic petroleum hydrocarbon solvent—120°F

*Try these tests to end the confusion*

118

So many conflicting claims have been made about virtually every coal tar epoxy coating on the market that prospective users are finding it difficult to fish out the facts from a sea of superlatives.

Perhaps you can find *your* answer by duplicating any or all of these laboratory tests comparing the four leading coal tar epoxies.

**THE TESTS:** The rods and panels illustrated here were carefully coated to the four manufacturers' specifications and then subjected for three months to the corrosive agents indicated above. The wide range of tests included varying concentrations of chemicals, ambient and elevated temperatures, weathering and all usual types of exposure.

**THE RESULTS:** Some results were predictable, such as the failure of all four coatings to withstand aromatic petroleum hydrocarbon solvent. But striking differences occurred in such tests as oxygenated salt water, when only Coating A (Amercoat No. 78) resisted undercutting. Products B, C and D were all blistered and undercut to varying degrees. In none of the remaining tests was Amercoat No. 78 excelled, and in most cases it showed marked superiority.

**CONFIRMATION:** The properties attributed to No. 78 in these tests have been substantiated repeatedly in actual field use. Applicators like it because it (1) gives dependable, all-around protection, (2) sprays more easily than competitive products, (3) builds thick films without difficulty because of its higher solids content, and (4) dries thoroughly but at a moderate rate, avoiding the extremes of prolonged tackiness and fast-dried brittleness.

Because of the unusual importance of these tests to prospective users of coal tar epoxy coatings, we have prepared illustrated copies of the complete report. Write for yours today!

(Amercoat No. 78 was formerly designated No. 1686)



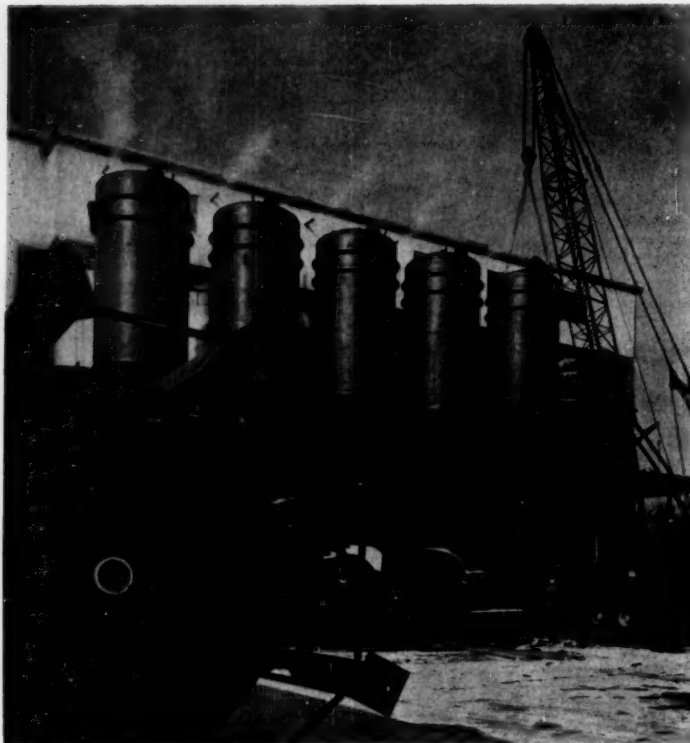
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Evanston, Ill. Kenilworth, N.J. Jacksonville, Fla. Houston, Texas

## FIRMS IN THE NEWS

R. A. LABINE

### NEW FACILITIES



#### These New Fermentation Vessels to Produce Citric Acid

Miles Chemical Co. is completing construction of its new 7,500-ton/yr., citric acid plant at Elkhart, Ind. New plant to cost \$3.6-million will make use of recently developed improvements on Miles' process. In 12 large vessels, air blown through moldy sugar solution will promote citric-acid production. Process thus resembles those used for antibiotic production.

American Chemical Corp. is constructing a polyvinyl chloride unit at its \$7.5-million Watson, Calif., expansion site. PVC unit being built by Scientific Design Co., New York, N. Y., is an addition to ethyl chloride, ethylene di-

chloride and vinyl chloride monomer units, now being constructed by C. F. Braun and Co., Alhambra, Calif.

Stauffer Chemical Co.'s Mexican affiliate, Industrias Quimicas de Mexico, S. A., announces plans for construction of a citric acid plant in Vera Cruz. New facility is scheduled to go on stream by mid-1960.

Du Pont announces plans to construct a polyethylene plant at its Victoria, Tex., Works and a 25,000-ton/yr. caprolactam plant at its Beaumont, Tex., plant. Caprolactam plant is scheduled to go on stream

## G-B SNAP\*ON DISTRIBUTORS

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BIRMINGHAM, Ala., Shook & Fletcher Supply Co.  
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Thermal conductivity . . . . .	0.590 (air equals 1)
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Volume, cu. ft./lb . . . . .	8.79 @ 70° F.
Pressure, saturated . . . . .	852.5 psia @ 70° F.
Cost, 100 cu. ft. . . . .	\$0.455 (CO <sub>2</sub> costing \$.04/lb)

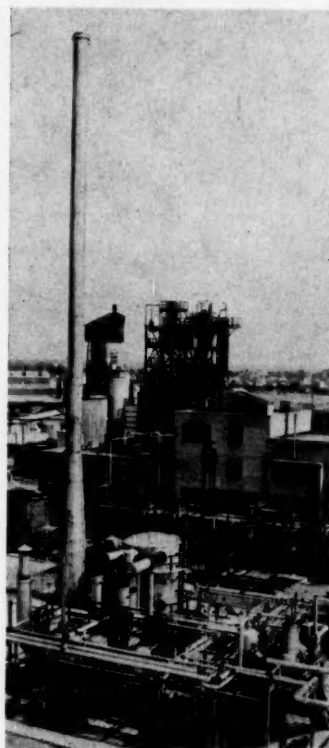


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**FIRMS . . .**

by the end of 1960, will produce intermediate chemical for nylon-6 manufacture.



**Socony Mobil Oil Co.** has just completed construction of its new 100-ton/day sulfur-recovery unit at Paulsboro, N. J. Badger Manufacturing Co., Cambridge, Mass., engineered and constructed the new unit, shown above.

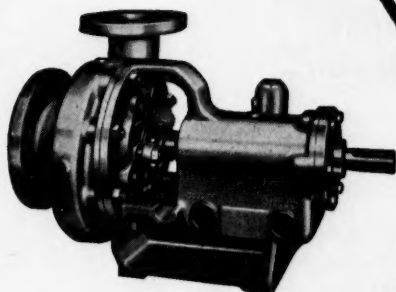
**Dow Chemical Co.** has installed a \$2,250,000 incineration plant at its Midland, Mich., site to minimize air and water pollution by processing wastes.

**Minnesota Mining & Manufacturing Co.** reveals plans for construction of a \$4.5-million fluorine-chemicals plant at Decatur, Ala. Production, to begin early in 1961, will be for the most part captive.

**Du Pont** announces construction of a metallurgical research center for the development of

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## PEERLESS CHEMICAL PROCESS PUMPS



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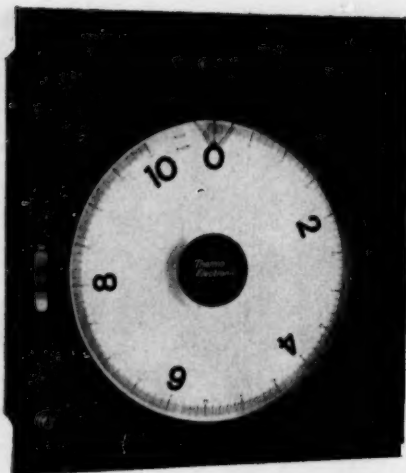
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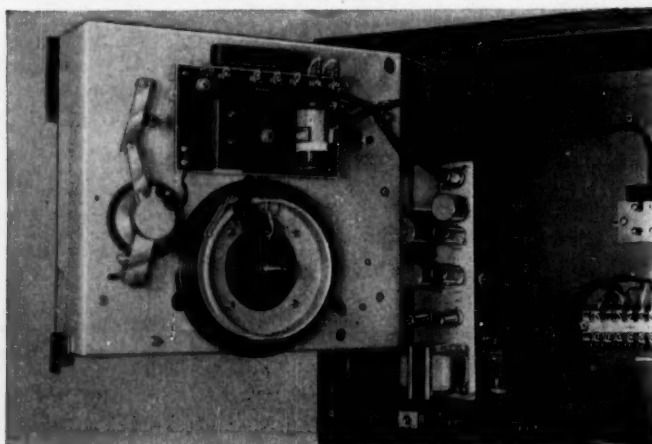
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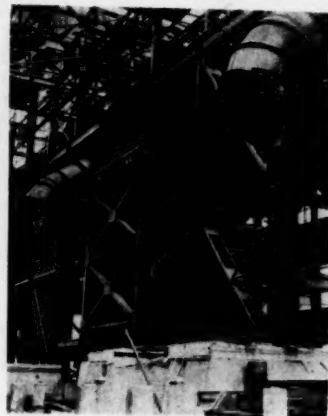
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### FIRMS . . .

space-age columbium and other alloys at Baltimore, Md. Researchers will move into the new facility by the fall of 1960.

National Starch and Chemical Co., Ltd. has begun production of polyvinyl emulsions at its Toronto, Ont., facility. Product is marketed as a base for adhesives, paints and textiles.



International Nickel Co., Inc. is constructing a 37,500-ton/yr. nickel plant at Thompson, Manitoba, to be completed by 1961. Shown above are converter hoods looming above the converter aisle, now under construction. Also to be constructed at the new Thompson site is a nickel refinery to use direct electrolysis of nickel matte (*Chem. Eng.*, Apr. 7, 1958, pp. 60-62).



Sun Oil Co. has begun construction of a \$2-million propylene plant at Marcus Hook, Pa.

## How Blaw-Knox cuts your power piping costs

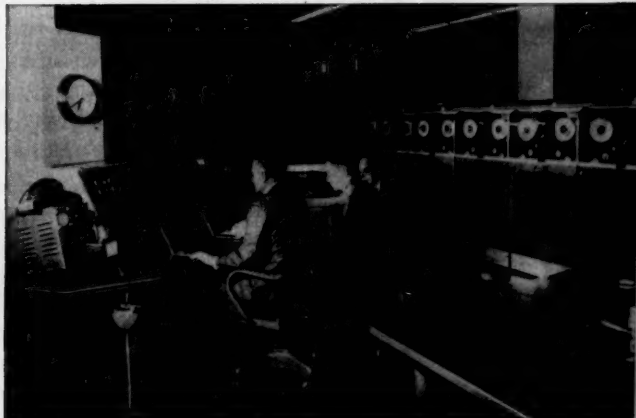


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**New product development.** Blaw-Knox developed an enclosed type of functional spring hanger as part of their complete line of hangers for supporting any piping system. Here a group of hangers individually designed for a project is factory checked to assure fast field erection.



**Stress calculation cut from months to a day . . .** with pace-setting engineering. An exclusive Blaw-Knox method uses an electronic computer for automatic computation with no limitation on the complexity of system. Full accuracy, with tremendous savings in time and cost. Write for details.



**BLAW-KNOX COMPANY**

*Power Piping Division*

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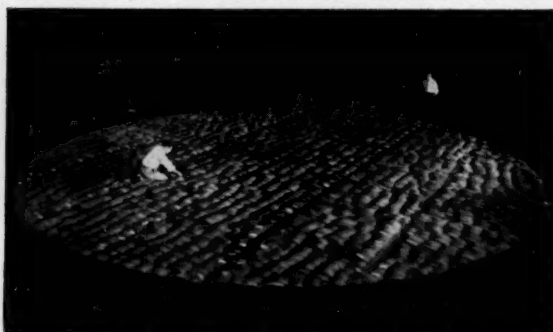
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NOW FIRST AGAIN with POLYETHYLENE  
for maximum corrosion resistance!

Since 1943, when it first introduced knitted wire entrainment separators—Metal Textile has been consistently first in introducing new developments to the field. In response to requests from chemical and processing engineers throughout industry—Metex engineers have utilized new materials...developed special meshes...initiated revolutionary techniques to provide low-cost, high-efficiency answers to the most complex entrainment problems. Your specific needs can be similarly solved. Our engineers, backed by the most extensive research and production facilities in the field, will be glad to recommend the type of Metex Mist Eliminator and method of installation best suited to your particular operating conditions. For latest design guides, write or call for Bulletin ME-9: Metal Textile Corporation, Roselle, New Jersey.

38' dia. Metex Hi-Thruput Mist Eliminator for world's largest vacuum pipe still.



**METAL TEXTILE CORPORATION**  
...world's largest and oldest producer of knitted wire products  
A DIVISION OF GENERAL CABLE CORPORATION

## FIRMS . . .

Main units in the new plant are two 145-ft.-high distillation towers with a total of 145 fractionating plates. Shown above is one of the towers on route to the plant site from Sun Shipbuilding & Dry Dock Co.'s fabricating plant.



**Arkansas Louisiana Chemical Corp.** has begun operating its new facilities at the Hamilton Products Extraction Plant near Magnolia, Ark. New \$3-million facilities permit production of ethane, butane and propane from natural gas.

**Texas Butadiene & Chemical Corp.** has brought on stream its new propylene recovery plant at Channelview, Tex. New unit salvages propylene from a Houdry butane dehydrogenation effluent stream.

**National Aniline Div. of Allied Chemical Corp.** is increasing its maleic anhydride capacity at Moundsville, W. Va., and Buffalo, N. Y. Both expansions are scheduled for completion by the end of this year to meet rising demand for maleic anhydride.

**American Agricultural Chemical Co.** has awarded Leonard Construction Co., Chicago, Ill., a \$750,000 contract for construction of a contact sulfuric acid plant at Cairo, Ohio. Plant is scheduled for completion by March 1960.

**Bowater Carolina Corp.** has begun operating its 134,000-ton/yr. semi-bleached sulfate pulp mill near Rock Hill, S. C. Construction, began in the spring of 1957, cost more than \$38-million.

**Sherbrooke Metallurgical Co., Ltd.** is constructing zinc-ore roasting and sulfuric acid plants at Port Maitland, Ont. Ore roasting plant will employ a recently developed fluid-bed roaster.

**Eastman Kodak Co.** recently opened a research laboratory for high-pressure research. Facility is equipped with safety cubicles and reactors to carry out reactions at pressures up to 30,000 psi.

**Dow Chemical Co.** announces plans to convert the vacant Findlay, Ohio, plant of National Automotive Fibres, Inc., to polyethylene-film producing facility.

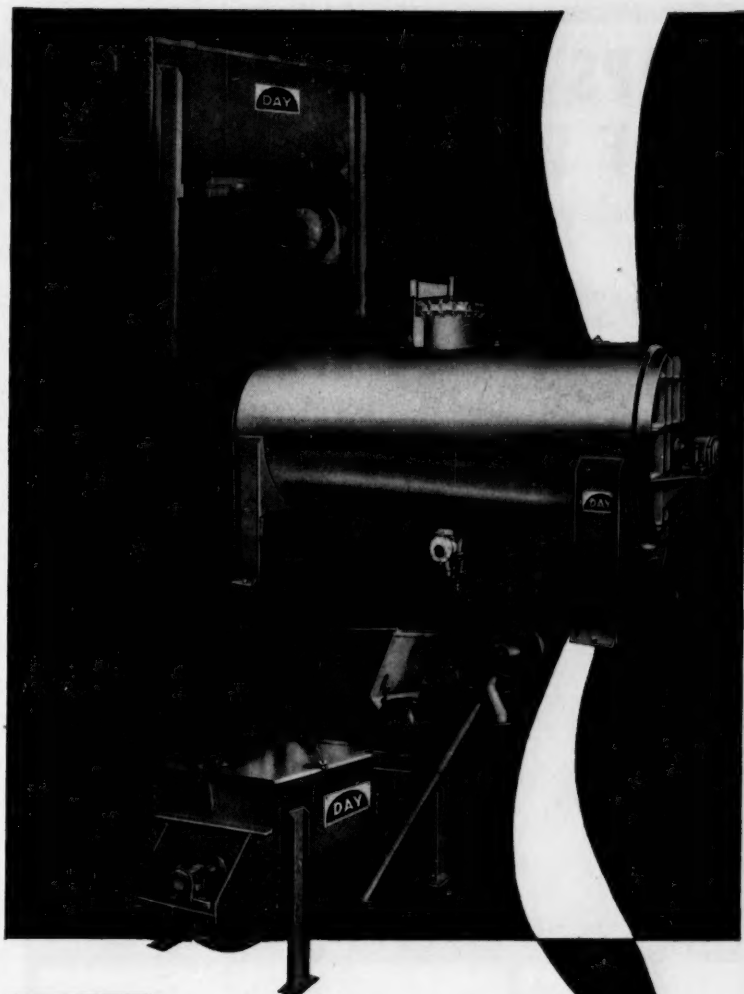
## NEW LOCATIONS



**Western Petroleum Refiners Assn.** is moving its national headquarters to a new office in Tulsa, Okla. WPRA, now 47 years old, is the world's largest organization of petroleum refiners.

**Lithium Corp. of America** announces plans to move manufacturing, research and development facilities from St. Louis Park, Minn., to Bessemer City, N. C., near its large ore reserves and chemical plant. Corporate offices will be moved to the East Coast too.

**Century Chemical Corp.** has moved to a new main office in New York, N. Y. Century produces and markets dyes, pigments and intermediates for the pharmaceutical and chemical industries.

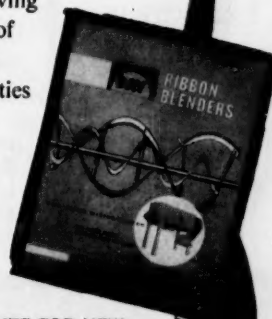


**DAY**

## builds RIBBON BLENDERS

*to meet all your needs - - -*

for perfect blending of powders, pastes or liquids. DAY builds ribbon blenders having rugged tanks of many designs, in a variety of materials . . . with powerful drives . . . and various types of agitators . . . in capacities that range from 7½ to 3850 gallons. Often combined with such allied DAY equipment as Ro-Ball or Brush Sifters that save floor space and increase your efficiency. Whatever your mixing requirements, there's no better buy than a low cost, trouble-free DAY Ribbon Blender!

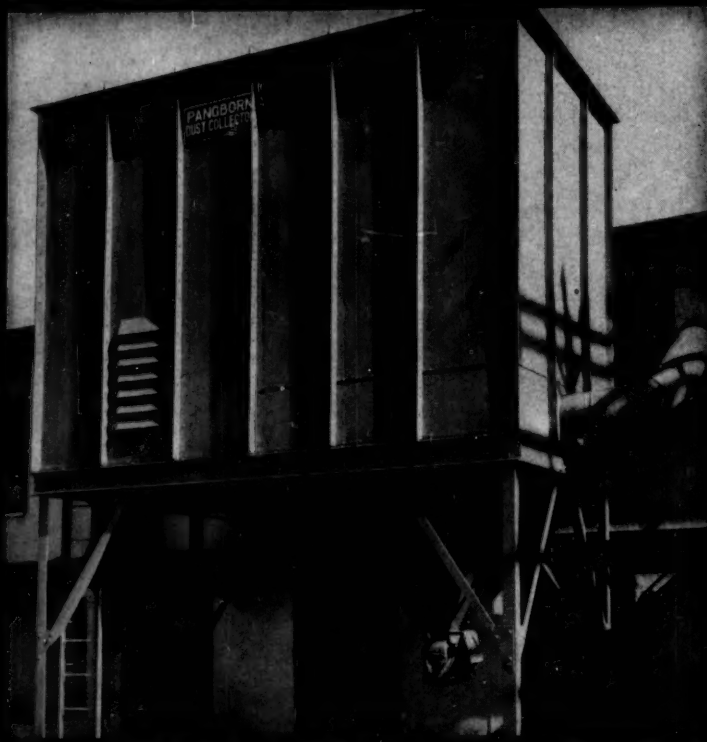


**WRITE FOR NEW BULLETIN No. 800.** It gives you detailed information on the complete line of DAY RIBBON BLENDERS.

**The J. H. DAY Co.**  
Division of The Cleveland Automatic Machine Co.  
4926 Beech Street, Cincinnati 12, Ohio

MANUFACTURERS OF QUALITY MIXING, BLENDING, SIFTING, MILLING EQUIPMENT SINCE 1887

# TRAPS ALMOST 4 CU. FT. OF DUST PER WEEK



**One small  
Pangborn  
Dust Control  
system replaces  
8 collector  
units profitably  
at Precision  
Rubber  
Products**

At Precision Rubber Products Corporation, Dayton, Ohio, millions of seals pass through a buffing process every year. The resulting dust could constitute an operating and housekeeping hazard. To facilitate dust control, the company replaced eight individual collector units with a central Pangborn Dust Control system. This installation saves floor space, operates quietly and gives efficient dust control (trapping almost 4 cu. ft. of rubber dust per week). Dust is now removed from one collector hopper instead of eight individual hoppers.

If dust is a problem in your plant, talk to the Pangborn man in your area or write PANGBORN CORPORATION, 2600 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Dust Control and Blast Cleaning Equipment—Rotoblast® Steel Shot and Grit.*

## Pangborn

## CONTROLS DUST

## CALENDAR

**American Society of Mechanical Engineers, International Air Pollution Congress, Statler-Hilton Hotel.**

Sept. 10-11 New York, N. Y.

**Armed Forces Chemical Assn., annual meeting, Statler Hotel.**

Sept. 10-11 New York, N. Y.

**American Chemical Society, national meeting.**

Sept. 13-18 Atlantic City, N. J.

**National Industrial Conference Board, 7th annual Marketing Conference, Waldorf-Astoria Hotel.**

Sept. 16-18 New York, N. Y.

**Natural Gasoline Assn. of America, Rocky Mountain Regional Meeting, Gladstone Hotel.**

Sept. 17 Casper, Wyo.

**Canadian Agricultural Chemicals Assn., annual meeting, Chateau Frontenac.**

Sept. 20-23 Quebec City, Que.

**Chemical Market Research Assn., conference: Textile Fibers.**

Sept. 20-22 Williamsburg, Va.

**Technical Assn. of the Pulp and Paper Industry, 14th Paper-Plastics Conference, Edgewater Beach Hotel.**

Sept. 21-23 Chicago, Ill.

**Instrument Society of America, 14th annual Instrumentation-Automation Conference and Exhibit, Amphitheatre.**

Sept. 21-25 Chicago, Ill.

**Industrial Nuclear Technology Conference, Morrison Hotel.**

Sept. 22-24 Chicago, Ill.

**American Rocket Society, conference on solid propellants, Princeton University.**

Sept. 24-25 Princeton, N. J.

**American Society for Quality Control, Chemical Div., annual conference, Shamrock Hilton Hotel.**

Sept. 24-25 Houston, Tex.

**International Union of Pure and Applied Chemistry, 20th conference.**

Sept. 26-29 Munich, Germany

**American Institute of Chemical Engineers, national meeting, Hotel St. Paul.**

Sept. 27-30 St. Paul, Minn.

**American Oil Chemists Society, fall meeting, Statler Hotel.**

Sept. 28-30 Los Angeles, Calif.

**American Institute of Mining, Metallurgical and Petroleum Engineers, Div. of Petroleum Engineers, fall meeting.**

Oct. 4-7 Dallas, Tex.

**Packaging Specifications Conference, Purdue University.**

Oct. 5-6 Lafayette, Ind.

**American Gas Assn., national conference, Conrad-Hilton Hotel.**

Oct. 5-7 Chicago, Ill.

**International Symposium on High-Temperature Technology**, arranged by Stanford Research Institute.  
Oct. 6-9 Asilomar, Calif.

**Society of Plastics Engineers**, Technical meeting: Vinyl Plastics.  
Oct. 7 Cleveland, Ohio

**American Vacuum Society**, annual meeting, Penn Sheraton Hotel.  
Oct. 7-9 Philadelphia, Pa.

**American Society for Testing Materials**, Pacific Area National Meeting, Sheraton-Palace Hotel.  
Oct. 11-16 San Francisco, Calif.

**Assn. of Agricultural Chemists**, annual meeting, Shoreham Hotel.  
Oct. 12-14 Washington, D. C.

**Technical Assn. of the Pulp and Paper Industry**, engineering conference, Penn Sheraton Hotel.  
Oct. 12-15 Pittsburgh, Pa.

**Western Agricultural Chemicals Assn.**, fall meeting, Villa Hotel.  
Oct. 13-14 San Mateo, Calif.

**Society of Plastics Engineers**, technical conference, Ambassador Hotel.  
Oct. 13-14 Los Angeles, Calif.

**Natural Gasoline Assn. of America**, southern meeting, Carlton Hotel.  
Oct. 16 Tyler, Tex.

**American Production and Inventory Control Society**, annual technical conference, Hotel New Yorker.  
Oct. 16-17 New York, N. Y.

**International Fair of the Plastics Industry**, Europe Hall.  
Oct. 17-25 Dusseldorf, Germany

**American Coke & Coal Chemicals Inst.**, annual meeting, Greenbrier.  
Oct. 19-20 White Sulphur Spa., W. Va.

**American Standards Assn.**, national conference, Sheraton-Cadillac Hotel.  
Oct. 20-22 Detroit, Mich.

**National Agricultural Chemicals Assn.**, national meeting, Sheraton Lick Hotel.  
Oct. 21-23 French Lick, Ind.

**National Lubricating Grease Institute**, annual meeting, Roosevelt Hotel.  
Oct. 26-28 New Orleans, La.

**Independent Petroleum Assn. of America**, annual meeting, Statler-Hilton Hotel.  
Oct. 26-27 Dallas, Tex.

**American Institute of Chemical Engineers**, New York Section, annual symposium, New Yorker Hotel.  
Oct. 27 New York, N. Y.

**Canadian Chemical Specialties Manufacturers Assn.**, annual meeting and convention, Royal York Hotel.  
Nov. 2-4 Toronto, Ont.

**American Society for Metals**, annual exposition and congress, International Amphitheatre.  
Nov. 2-6 Chicago, Ill.

**American Nuclear Society**, national meeting, Sheraton Park Hotel.  
Nov. 4-6 Washington, D. C.

**Technical Assn. of the Pulp and Paper Industry**, Alkaline Paper Conference, Robert Meyer Hotel.  
Nov. 4-6 Jacksonville, Fla.

## HIGHEST FLOW RATES

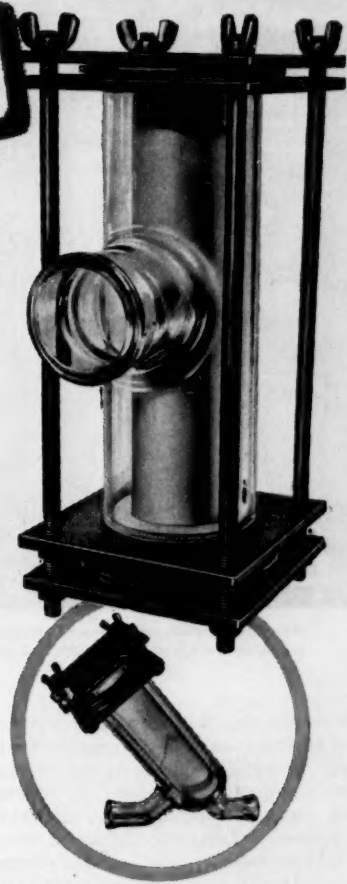
## MINIMUM PRESSURE DROP

## COMPLETE CHEMICAL RESISTANCE

**NEW**

### *Chem Flow* **FPT FILTERS**

- Constructed of PYREX\* Brand tubing and Teflon
- Transparent body
- Permanent filter element
- Compact design
- High heat resistance
- Uniform structure, voids and particle retention
- Complete micron porosity range



FPT Filters are a new type of filter assembly... completely resistant to chemical attack and ideally suited for filtration of liquids, gas diffusion and purification. The extremely hard and permanent filter element offers maximum particle retention with very high flow rate. The porosity range covers one to 100 microns. Use Chem Flow FPT Filters for sterilization, clarifying, polishing applications at pressures up to 50 psi, temperatures as high as 450°F. Available in angle and "Y" types.

For specifications and performance data, write for Bulletin FPT-2.

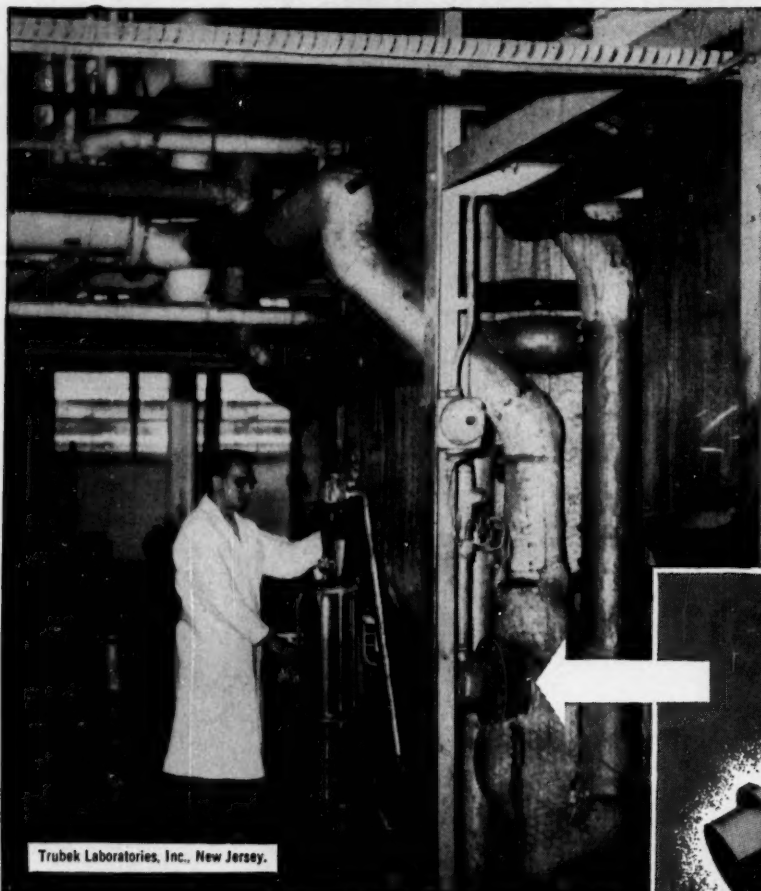
\*Trade Mark, Corning Glass Works



**CHEM FLOW CORP.**

119 Dell Glen Avenue • Lodi, New Jersey

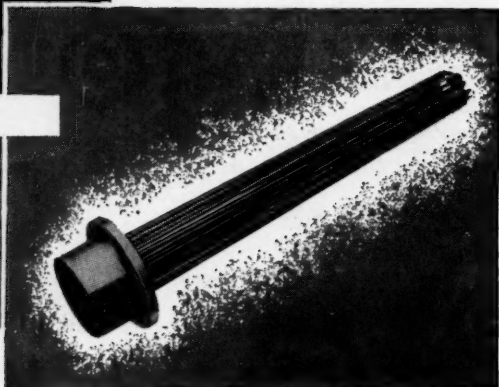
Call your Chromalox Man for answers to . . .



Trubek Laboratories, Inc., New Jersey.

When temperature requirements could no longer be met by a hot tempering oil central system, Chromalox "job-side" heating provided the answer.

**Widely  
different  
temperature  
requirements  
on various  
processing  
vessels**



Recently, this New Jersey company converted an old hot-oil central system to Chromalox electric "job-side" heating. In addition to being troublesome, the old system could not provide the variety of temperatures required for their growing diversity of products. Switching to Chromalox Immersion Heaters, they now use Aroclors and Dowtherm as heat transfer media. On one 350-gallon vacuum still, 18kw of heat capacity now provides temperatures of 290°C. Chromalox Type TMO Immersion Heaters operate in the bottom of the vented vessel jacket which contains the heat transfer medium. Using 30kw, a 450-gallon sealed jacket reactor can attain temperatures to 325°C, using Dowtherm-A.

Since some vessels had previously been equipped with steam coils or were glass-lined, insertion of heaters into

the vessel or jacket was impractical. Instead, transfer media is heated adjacent to the vessel and circulated by sump-type centrifugal pump.

Perhaps your Chromalox Man, listed at the right, can help you solve some of your heating problems the easy, economical, *electrical* way. Why not give him a call for *Faster heating* of water, oils, Dowtherm, Prestone. *Faster melting* of grease, asphalt, solder, babbitt. *Faster superheating* of steam, compressed air.

4994



**CHROMALOX**  
*Electric Heat*  
INDUSTRIAL • COMMERCIAL • RESIDENTIAL  
EDWIN L. WIEGAND COMPANY  
7514 Thomas Boulevard • Pittsburgh 8, Pa.

**CHROMALOX** has a complete line of electric heaters to meet all your liquid processing requirements:





## Call Chromalox for the man with the Electrical Answers to your heating problems

**ATLANTA 8, GA.**  
Applebee-Church, Inc.  
1389 Peachtree St., N.E.  
Trinity 5-7244

**BALA-CYNWYD, PA.**  
J. V. Calhoun Company  
349 Montgomery Ave.  
Mohawk 4-6113  
Greenwood 3-4477

**BALTIMORE 18, MD.**  
Paul V. Renoff Company  
333 East 25th St.  
Hopkins 7-3280

**BINGHAMTON, N. Y.**  
R. P. Smith Co., Inc.  
94 Henry St.  
Phone 4-7703

**BLOOMFIELD, N. J.**  
R. L. Faber & Assoc., Inc.  
1246 Broad St.  
Edison 8-6900  
New York: Worth 4-2990

**BOSTON 11, MASS.**  
Leo C. Pelkus & Co., Inc.  
683 Atlantic Ave.  
Liberty 2-1941

**BUFFALO 2, N. Y.**  
Niagara Electric Sales Co.  
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Summer 4000

**CHARLOTTE 2, N. C.**  
Ranson, Wallace & Co.  
116½ E. Fourth St.  
Edison 4-4244  
Franklin 5-1044

**CHATTANOOGA 1, TENN.**  
H. R. Miles & Associates  
P. O. Box 172  
Amherst 5-3862

**CHICAGO 5, ILL.**  
Fred I. Tourtelot Company  
407 S. Dearborn St.  
Harrison 7-5464

**CINCINNATI 5, OHIO**  
The Smyser Company  
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Trinity 1-0605

**CLEARWATER, FLA.**  
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617-A Cleveland St.  
P. O. Box 1376  
Phone 3-7706

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2012 W. 25th St.  
Prospect 1-7112

**DALLAS 26, TEX.**  
L. R. Ward Company  
3009 Canton St.  
Riverside 1-9004

**DAVENPORT, IOWA**  
Volco Company  
215 Kahl Building  
Phone: 6-5233

**DENVER 2, COLO.**  
E. & M. Equipment Co.  
2415 Fifteenth St.  
Glendale 5-3651  
Genesee 3-0821

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Midwest Equipment Co.  
of Iowa  
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Cherry 3-1203

**DETROIT 28, MICH.**  
Carman Adams, Inc.  
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University 3-9100

**HOUSTON 2, TEX.**  
L. R. Ward Company  
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Capitol 5-0356

**INDIANAPOLIS 5, IND.**  
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1400 N. Illinois St.  
Station A, P. O. Box 88023  
Melrose 5-5313

**KANSAS CITY 6, MO.**  
Fraser D. Moore Co.  
106 W. 14th St.  
Victor 2-3306

**LOS ANGELES 16, CAL.**  
Montgomery Brothers  
1053 S. Olive St.  
Richmond 7-9401

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Diamond 6-9606

**MILWAUKEE 2, WIS.**  
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Broadway 1-3021

**MINNEAPOLIS 4, MINN.**  
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Federal 6-3373

**NASHVILLE 4, TENN.**  
H. R. Miles and Associates  
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Cypress 2-7016

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See "Bloomfield, N. J."

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See "Bala-Cynwyd, Pa."

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Montgomery Brothers  
1122 Howard St.  
Underhill 1-3527

**SEATTLE 4, WASH.**  
Montgomery Brothers  
911 Western Ave.  
Main 4-7297

**SYRACUSE 5, N. Y.**  
R. P. Smith Co., Inc.  
2507 James St.  
Howard 3-2748

**WICHITA 2, KAN.**  
Fraser D. Moore Co.  
Room 211 Derby Building  
352 N. Broadway  
Amherst 2-5647

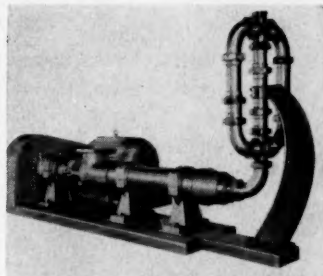
**EXPORT DEPARTMENT**  
1010 Schaff Building  
Philadelphia 2, Pa.

## NEW EQUIPMENT . . .

(Continued from p. 106)

every 5 min. by Richardson Scale's new proportioning system. Developed for the proportioning of various types of clays in connection with oil refining processes, it readily can be adapted to other materials with similar characteristics.

Major components of the system are a scale, a panel and feeder assemblies. Scales are dial type, equipped for fixed-sequence feeding of materials. Feeders utilize air-operated governors to control finely ground clays that tend to flush when withdrawn from storage bins. The remote control panel includes both manual and automatic instruments in two separate circuits.—Richardson Scale Co., Clifton, N. J. 106F



## Ultrasonic Homogenizer

Cavitation - producing device for large flows.

Larger-capacity mechanical transducers have extended the upper output range of Sonic's line of homogenizers. Newest unit of the line, known as the Hydrasonic, can handle up to 9,000 gph. of process fluid. Power input for this machine is 30 hp., 220/440 v.

Basic operating principle of the Hydrasonic, like other members of the line, is development and application of the kinetic energy in the liquids. (See *Chem. Eng.*, Mar. 10, 1958, p. 94.) Liquids to be emulsified impinge in the form of a flat high-pressure jet stream on the edge of a blade that vibrates at about 22,000 cps. Cavitation takes place continuously in the stream rushing past the blade, causing

violent pressure changes within a resonant bell. The pressure fluctuations do the homogenizing job.—Sonic Engineering Corp., Stamford, Conn. 193A

## Fractometer Accessory

Remembers component peaks of cyclic analyses.

Automatic pneumatic control of any selected component of a process stream is now possible via a new control accessory for Perkin-Elmer's Model 184 process vapor fractometer.

Essentially, this accessory employs an auxiliary peak memory unit with integral graphic panel recorder. This replaces the standard recorder and augments the standard programmer. The device actually "picks out" and remembers a predetermined component peak of the four (or more) component cyclic analysis presented by the standard programmer. The remembered peak value may be used to pneumatically reset a conventional cascade control station.—The Perkin-Elmer Corp., Norwalk, Conn. 193B



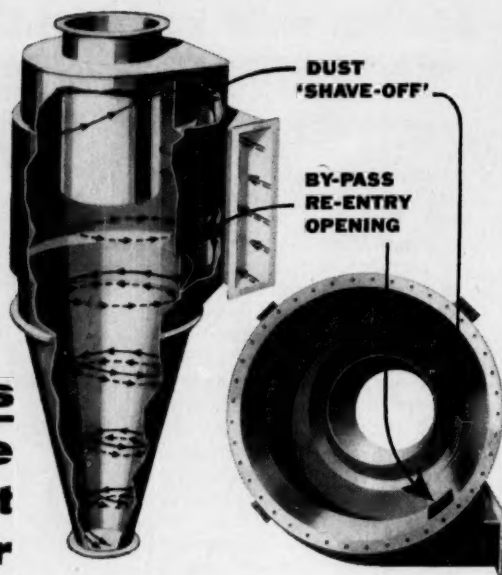
## Tractor Shovel

High-capacity unit added to manufacturer's line.

Produced to replace the Model HU Payloader, Model H-50 tractor shovels offer four-wheel drive, rubber tires and a carrying capacity of 5,000 lb.

Torque converter in the new unit is closely matched to engine and transmission characteristics. Torque-multiplication factor is 2.57:1 at stall. The power-shift transmission provides three speeds in each direc-

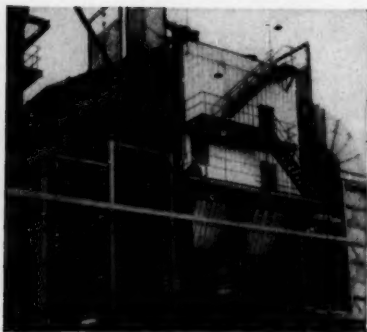
## **This Cyclone won't clog or plug**



**Buell's exclusive 'Shave-off' design** permits large diameter cyclones that will not clog, plug, or bridge when properly operated: you avoid unnecessary maintenance work or process interruptions.

The unique Shave-off port traps the dust that whirls upward in double-eddy currents, increases cyclone efficiency by eliminating this source of dust reentrainment. Whether installed singly or in groups, Buell Cyclones are the most efficient ever developed.

Other features include extra heavy plate construction for longer service life, Buell-designed manifolds for more efficient, non-turbulent flow of dust-laden gases . . . and the confidence assured by a history of hundreds of installations everywhere in America. Write for a copy of the 12-page booklet, "The Exclusive Buell Cyclone": Dept. 12-1, Buell Engineering Company, Inc., 123 William St., New York 38.



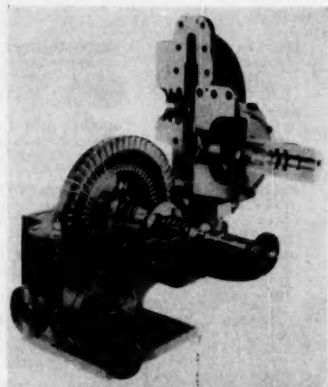
Large-diameter Buell Cyclones in series with Buell 'SF' Electric Precipitator.

# **buell®**

*Experts at delivering Extra Efficiency in*  
**DUST COLLECTION SYSTEMS**

### **NEW EQUIPMENT . . .**

tion. Power-transfer differentials are standard equipment on both front and rear axle assemblies. Engine output is 90 to 92 hp.—**The Frank G. Hough Co., Libertyville, Ill. 193C**



### **Gas-Expanding Turbine**

**Is fully reversible. Operates on pipeline gas.**

Applicable to gas-pipeline valve operations, a new gas-expanding turbine can deliver from 1 to 45 hp. Maximum inlet pressure is 1,000 psi.

Fully reversible in operation, Type GET turbines come equipped with a mechanical speed governor, manual speed change and an over-speed trip valve. Safe speed limit is 12,000 rpm.—**Dean Hill Pump Co., Indianapolis, Ind. 194A**

### **Foam Cleaner**

**Cuts maintenance costs for process equipment.**

Dowell Div. of Dow Chemical has announced a new method for cleaning industrial equipment. Cleansing agent is a foamed solvent of composition dependent on type of deposit being removed.

In service, foamed solvent from special foam-producing apparatus feeds into the tank, pipe or tower being cleaned. When the equipment is filled, the foam passes to a foam breaker, then to a filter that removes material dislodged by

movement of foam through the equipment. The solvent is then recycled through the foam generator. Routine tests tell when the job is finished.

Apparently, Dowell will soon offer this technique as part of their industrial chemical service.

Because the ratio of foam to solvent will average 20:1, the new method promises to cut cleaning expenses compared with those of liquid-solvent methods. It will also now be possible to chemically clean equipment that would not stand hydrostatic pressure accompanying all-liquid systems. And waste disposal problems following completion of cleaning will not be great because of the small quantity of solvent actually used.—Dowell Div., Dow Chemical, Tulsa, Okla. 194B



### Gate Valves

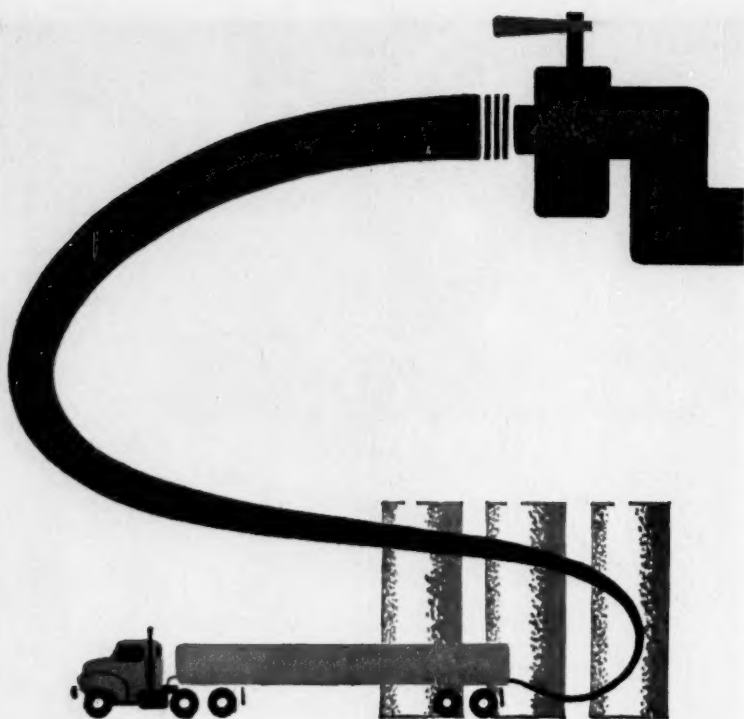
**Soft rubber compensates for wear on seats.**

Flow control on process or distribution lines for fluids, gases and slurries is readily handled by a new line of pressure-sealing, steel gate valves. Requiring no lubrication, the valves provide a tight seal both upstream and downstream. Claimed valve features include a full bore and through conduit, protected seats that automatically adjust for wear, automatic upstream relief for exces-

NEW FROM  
KAISER CHEMICALS

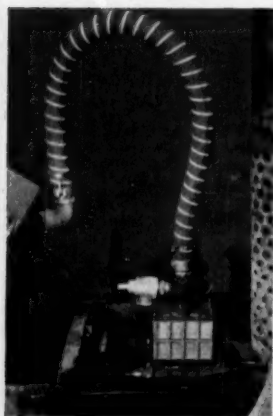
ACTIVE ALUMINAS

KAISER  
CHEMICALS



## NEW M-D GEARED P.T.O. BLOWERS... NO BELTS-NO PULLEYS

for tractor mounted conveyor systems



Now a compact, 3-lobe M-D blower fits *inside* tractor frame... weighs only 165 lbs. Geared-in-head blower (2 to 1 or 2½ to 1 ratios) connects directly to truck P.T.O.—no belts or pulleys—develops 15 PSIG continuous air flow or up to 18 PSIG in surges.

M-D blowers operate at wider pressure and speed ranges than any other rotary positive blower. Capacities of 22 production models range from 50 to 4,000 CFM, pressures to 15 PSIG single, 70 PSIG multi-stage.



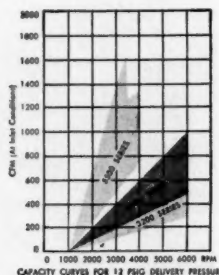
For full information write

**M-D BLOWERS, INC.**  
RACINE, WISCONSIN

A SUBSIDIARY OF



MIEHLE-GOSS-DEXTER, INC.

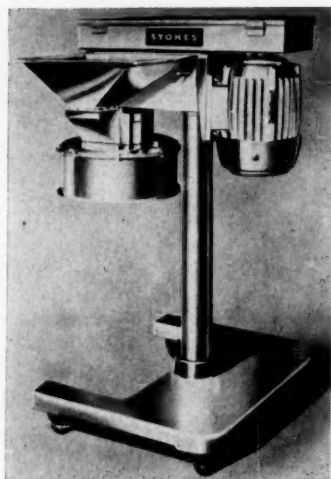


## NEW EQUIPMENT...

sive body pressure, and ease of maintenance.

Design of the floating seats is quite interesting. Each seat consists of two kinds of rubber, molded to a hardened steel insert, ringed with holes. Soft rubber covers the back of each seat, and tough, abrasive-resistant rubber covers the gate side. Pressure forces the soft rubber through the holes, reinforcing the tough rubber and compensating for any wear on the face of the seat.

A neoprene bellows indicator, colored bright yellow for long-range visibility, extends above the handwheel when the valve is open. The indicator also protects stem threads from dirt and corrosion. Sizes in ASA 150- and 300-psi. classes range from 2 to 30 in.—W-K-M Div., ACF Industries, Houston, Tex. 195A



## Granulating Machine

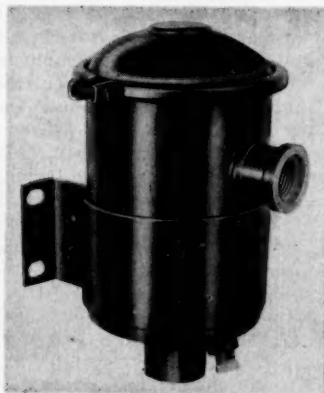
Reduces particle size of feed; blends materials.

According to the manufacturer, Tornado mills have chalk up outstanding performance records during their first year of marketing. The mill, a granulating and mixing machine of unique design, claims about 50 recent applications throughout the process industries.

A cluster of whirling blades attached to a common vertical shaft creates an air flow that

throws feed material outward at high velocity against a cylindrical mesh screen surrounding the rotor. In the process, material is reduced uniformly in particle size without excess fines, and is thoroughly mixed. Variation of the number of blades and their spacing, as well as change of screen size, adapts Tornado mills for operation giving the best results on any particular feed.

Stainless steel is the material of construction for all parts of the mill that contact feed processed. Motor size varies from 5 to 25 hp.—F. J. Stokes Corp., Philadelphia, Pa. 196A



#### Liquid/Gas Filter

Cleans high-pressure air or hydraulic systems.

New Purolator filters, designed for service in pneumatic and hydraulic systems, are capable of operating at pressures to 1,000 psi. and temperatures to 275 F. Degree of filtration with replaceable paper elements, wire mesh or metal-edge filtering media ranges from 2 to 25 microns. Clamp lock-ring construction on the steel housing affords easy element change without disconnection of filter from the circuit.

All units in the series come with mounting brackets, inlet and outlet connections and internal relief valves. Relief-valve settings vary from 15 to 20 psi. for lower differential pressures, and 45 to 55 psi. for higher pressures. For suction-side installations, 4- to 6-psi.



Apply Cementable Teflon to hoppers, mixers, feeders, chutes, packaging machines. Chemically-inert Teflon moves powders and mixtures swiftly, freely. Prevents material build-up without vibration equipment or manual attention.

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*Absolutely nothing sticks* to slippery Cementable TEFLON. For clean up, just wipe off surfaces . . . no time wasted in scraping or soaking with special solutions.

*Odorless, colorless, non-absorbent, non-contaminating, Cementable TEFLON* will withstand 500° F. with use of high temperature adhesives. It can be bonded to metal, wood, glass, other surfaces. Available in continuous tapes .005" through .096", through 24" wide; and in sheet through 48" x 48".

*Cementable TEFLON*, as made by Garlock's Plastics Division, the United States Gasket Company, can save you time and money. Find out how by contacting one of The Garlock Packing Company's 26 sales offices and warehouses in the U.S. and Canada, or write for Catalog AD-158.

\*DuPont Trademark for T.F.E.-fluorocarbon resin

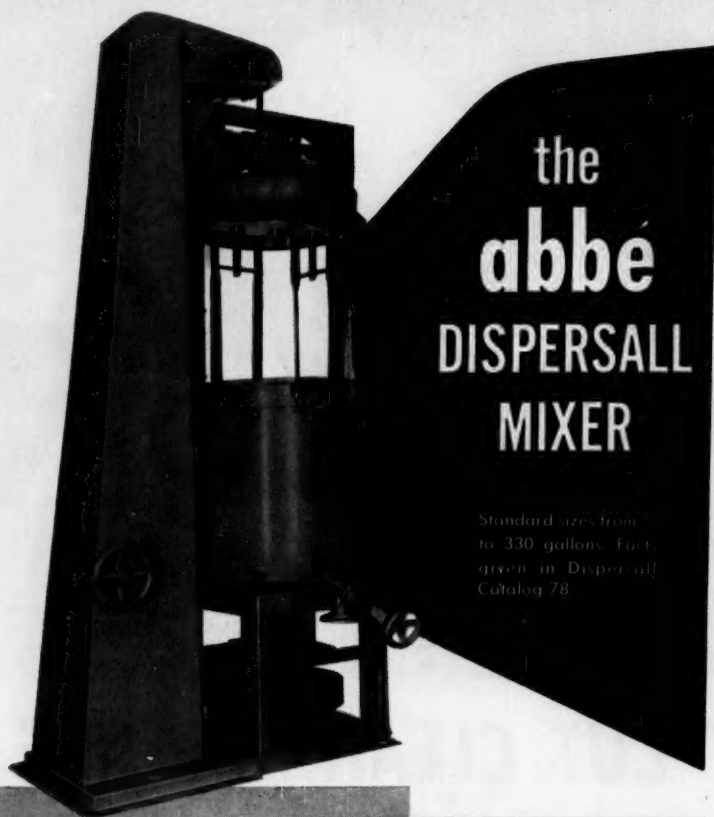
# United States Gasket

THE GARLOCK PACKING COMPANY  
Palmyra, N. Y.

Plastics Division of  
**GARLOCK**



# LIQUIDS, SLURRIES, PASTES

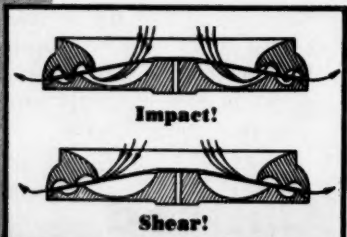
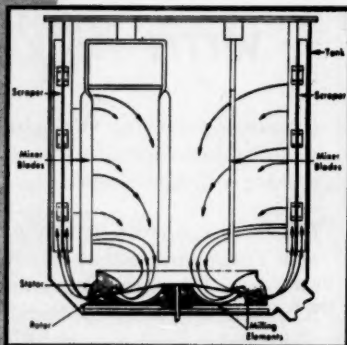


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Standard sizes from  
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**FAST,  
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COMPLETE  
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DISSOLVES  
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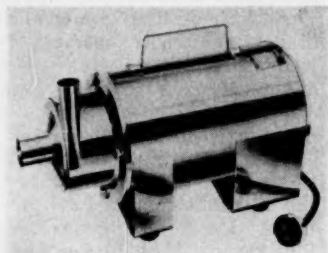


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620 F Graybar Bldg., New York 17, N. Y.

Designers and Manufacturers of  
Ball, Pebble and Jar Mills - Pulverizers - Sifters - Cutters - Mixers

### NEW EQUIPMENT . . .

settings are available.—Puro-  
lator Products, Inc., Rahway,  
N. J. 197A



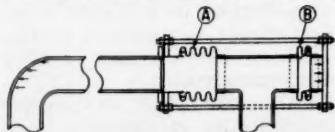
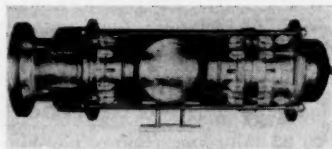
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For service with corrosive  
liquids. Low cost.

Compactly built, a new all-  
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offered for services requiring  
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pacity is 50 gpm. at 20 psi.

Standard inlet is 1½-in. O.D.  
stainless tubing; outlet, which  
is 1-in. O.D. stainless, may be  
positioned vertically or hori-  
zontally. Power source is a ¾-  
hp. single-phase motor over-  
equipped with automatic over-  
load protection.

According to the manufac-  
turer, simplified design and  
specially developed production  
techniques make pump price  
considerably lower than com-  
peting units of comparable ca-  
pacity.—Stainless Steel Pump  
Co., Griffith, Ind. 198A



### Expansion Joints

Install at points of direc-  
tion change.

Pressure-balanced expansion  
joints for absorbing pipeline

movement without imposing pressure thrust are available in diameters from 3 in. to 5 ft. Temperatures can vary from -320 to 1,600 F., and pressures to 2,500 psi.

Installed at elbows or points where piping changes direction, the joints use counterbalancing outer bellows to absorb line pressure where anchoring is not practical. The diagram above shows how this works.

Pressure in the expansion joint A surges against the elbow at left and against the closed end of balancing expansion joint B. Thus, force exerted by internal pressure against the line is balanced by an equal and opposite force, transmitted to the line through tie rods from the blanked end of the balancing expansion joint.—Zallea Bros., Wilmington, Del. 198B



### Glass Piping

Tempered ends add durability in service.

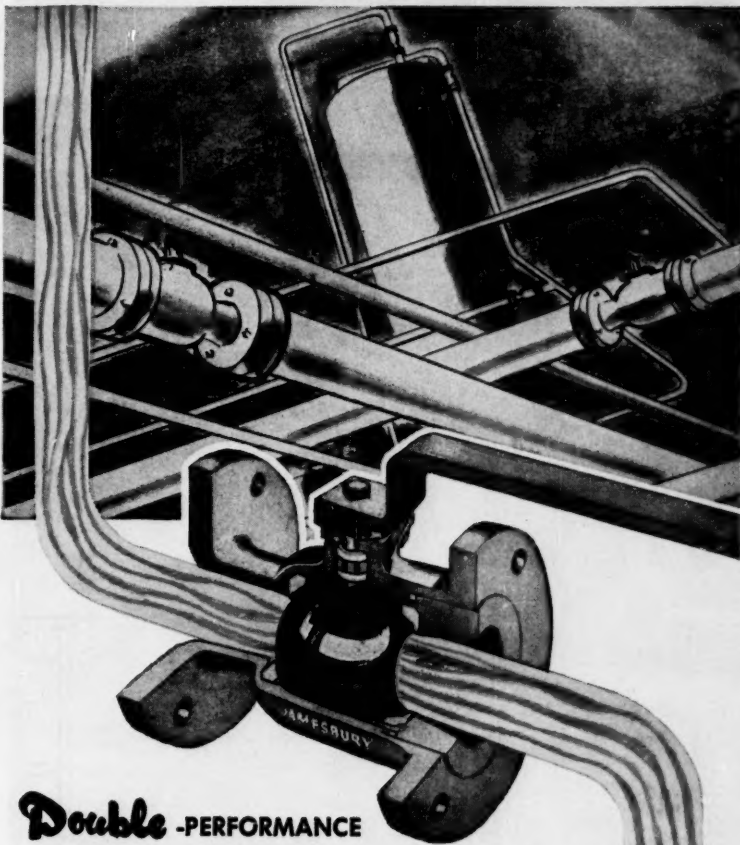
Manufactured from KG-33 borosilicate glass, a new line of tempered industrial pipe and fittings is claimed to match or excel the performance of any similar line now being produced. The products' high heat resistance allows application at temperatures to 450 F., with maximum sudden differentials ranging to 210 F. Maximum recommended working pressures range from 25 to 55 psi., depending upon pipe size.

All Kimax pipe and most of the fittings are tempered at both ends to provide added strength and durability. All products are interchangeable with other tempered hard-glass transmission systems having the same linear coefficient of

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## "Double-Seal" Ball Valves

### Give Double-Value



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Wherever the Jamesbury "Double-Seal" principle is employed in its multiple industrial applications, "Superior performance" is the phrase heard everywhere.

**PERFORMANCE** — the direct result of the high-efficiency and the long, maintenance free life of the Jamesbury product: "Double-Seal" Ball Valves.

Ball Valves in pipe sizes 1/4" to 8" in Bronze, Aluminum, Stainless Steel, Carbon Steel. PVC 1/2" to 4" Quarter-turn.

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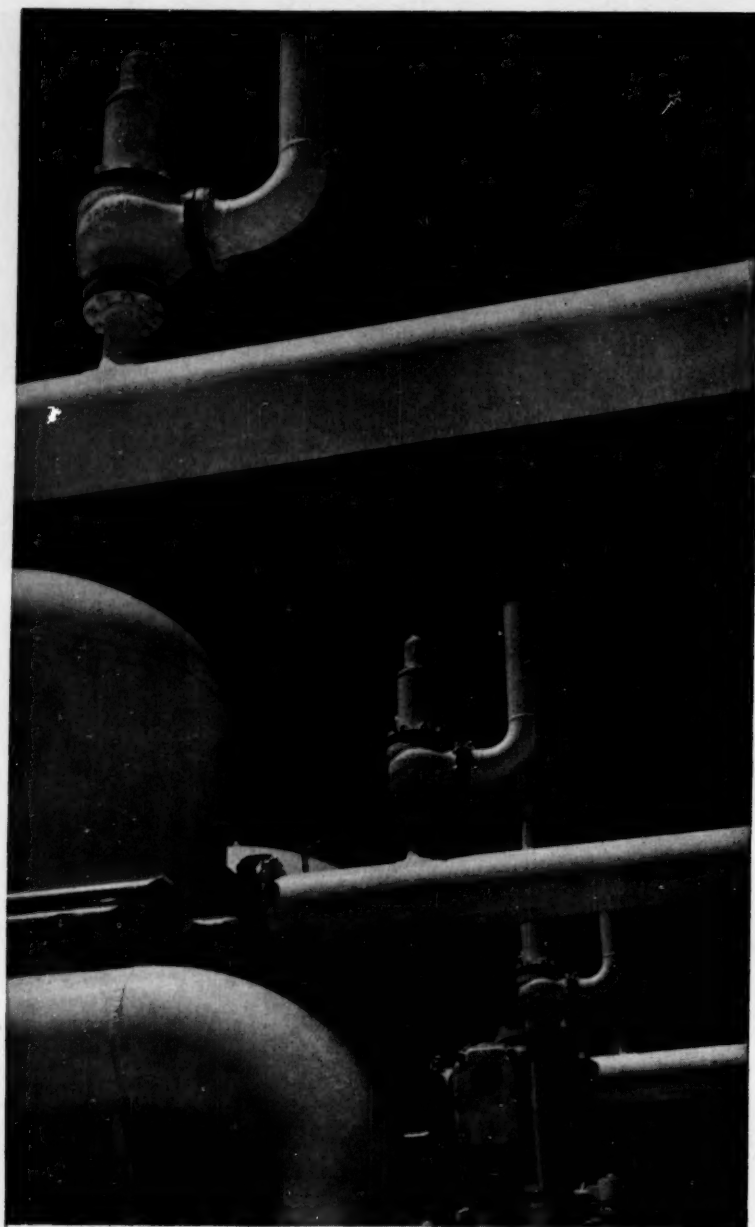
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Crosby Safety-Relief Valves on inlet scrubbers to gas booster station —  
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**Crosby**  
KEEPS PRESSURE ON THE SAFE SIDE

- Safety Valves for power boiler code requirements • Pressure Indicating and Recording Gages
- Safety-Relief Valves for unfired pressure vessel • Pressure Testing Instruments code requirements

**NEW EQUIPMENT . . .**

expansion. Producer is Kimble Glass Co., a subsidiary of the Owens-Illinois Glass Co.—Fischer & Porter Co., Hatboro, Pa. 199A

**BRIEFS**

**Drives** utilize improved V-belts having cross-sectional areas reduced nearly 50% with no loss in life expectancy. Small belts offer many advantages: narrower sheaves, smaller sheave diameters and shorter center distances. Narrower sheaves reduce shaft overhang and bearing loads, thereby increasing bearing life. Belt sizes to 1,500 hp.—The American Pulley Co., Philadelphia, Pa. 200A

**Lip-seal bonnet valve line** now covers three distinct pressure-temperature classifications rather than the two groups previously produced. Designed for power-plant service, the valves range in size from  $\frac{1}{2}$  through 2 in. One design change provides a centering shoulder; this eliminates any possibility of stem binding.—Crane Co., Chicago, Ill. 200B

**Self-draining valve** utilizes a special bolted bonnet to guarantee perfect alignment and freezeproof action under all conditions. A forged yoke supports the stem away from the body, and a separate gland-follower bears directly on the packing, entirely independent of the yoke. Known as No. 23, the valves are recommended for pressures to 4,000 psi. at 100 F., or 1,000 psi. at 750 F. (for  $\frac{1}{2}$ - and 1-in. size). Other sizes are  $1\frac{1}{2}$  and 2 in.—Jerguson Gage & Valve Co., Burlington, Mass. 200C

**Relief and back-pressure valves** made of PVC are available for corrosion-resisting applications not covered by other valves. Kel-F or Teflon-resin diaphragms protect upper internal parts from contact with liquids. Manufactured in  $\frac{1}{2}$ - and  $\frac{1}{4}$ -in. sizes, the

*a filter man's thinking*

## FORESIGHT:

Developing the solution before the problem comes up

It takes a long time to translate the need for a new aircraft into an actual piece of flightworthy hardware. It can take forever — if its special operating requirements can't be met by known materials and components. Few jets would be in the air today if certain industrials — like Purolator — hadn't recognized that difficult operating conditions had to be anticipated long in advance.

A modern aircraft has a maze of circulatory systems: fuel, air, lubrication, pneumatic, and hydraulic lines . . . instrument systems, etc. — with filters playing an important role in each. In high performance jets extremes of temperature, pressure, flow and structural strain . . . and the need to handle chemically-active fluids . . . preclude the use of the kinds of filters which had proved adequate for older aircraft. To fill the gap, our engineers some years ago developed Purolator's famous porous metal filter medium. This type of filter has since been brought to a high degree of efficiency.

Purolator makes these media by a unique method of fusing metal powders of controlled particle size to obtain the desired porosity. The metals used are matched to specific service requirements — and include all grades of stainless steel, nickel, monel, Inconel, Hastelloy, bronze, gold, silver, etc.

We can fabricate these media into almost any shape you care to name. We can control pore size to within 10% even when down as small as 0.2 microns. We can sinter the elements to fittings of the same or other materials. We can vary wall thickness from .015 inches up. We can apply thin layers of porous metal to other types of media. We can squeeze 500 square inches of filter area into an element 3½ inches in diameter and 10 inches long.

Many of these filters can withstand pressures up to 6000 psi . . . temperatures from -420° to 1200°F . . . severe corrosive environments. In addition to aircraft, they're being widely used in chemical, nuclear, petroleum and other industries — for filtration, contamination control, separation of liquids, and diffusion applications.

"Filter Media Selection Chart"—giving corrosion and temperature factors for all known media—is a valuable reference to have on hand. Write us—it's yours free.

*Jules P. Kovacs*  
Jules P. Kovacs, V. P.

Filtration For Every Known Fluid

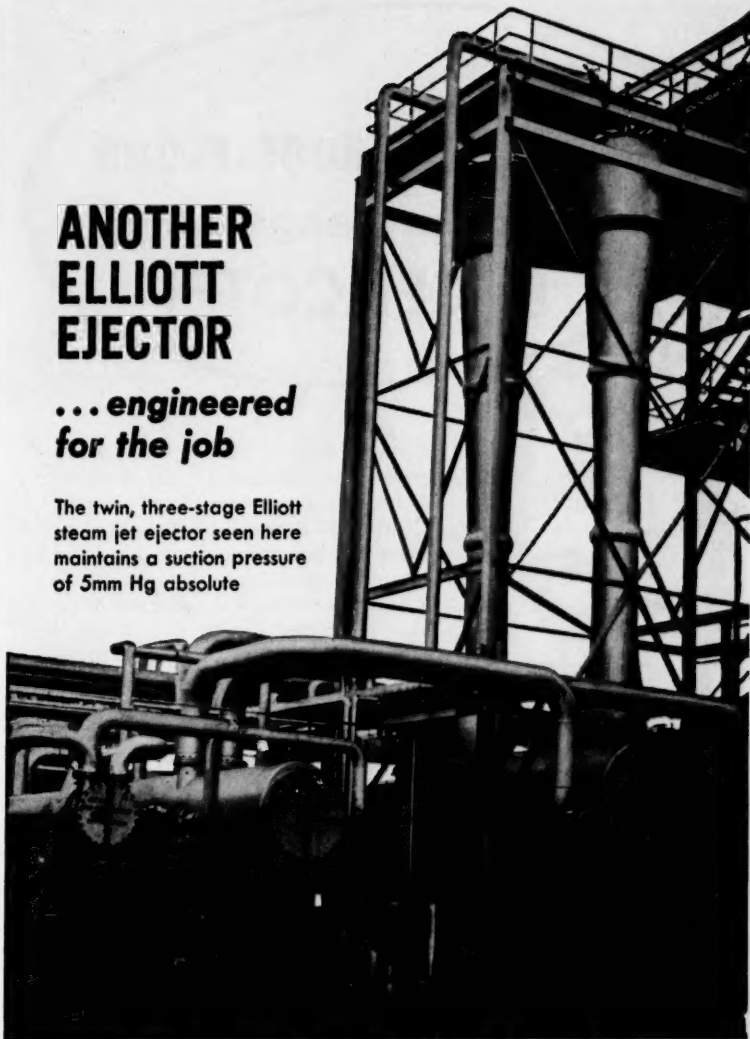
**PUROLATOR**  
PRODUCTS, INC.

Rahway, New Jersey and Toronto, Ontario, Canada

## ANOTHER ELLIOTT EJECTOR

**... engineered for the job**

The twin, three-stage Elliott steam jet ejector seen here maintains a suction pressure of 5mm Hg absolute



### *designed to serve world's largest crude oil unit*

This unique, giant-sized ejector is the largest vacuum installation ever built. The design problem here was to engineer a unit which would efficiently and economically maintain the specific suction pressure required by the application. To accomplish this, Elliott engineers designed a twin-type ejector with two vertical first-stages which are 40 ft long, have 60-inch diameter inlets, and discharge to a 20,000-sq ft intercondenser. The two 20-inch second-stage ejectors discharge to a 6000-sq ft intercondenser and the third-stage ejectors discharge to a 3000-sq ft aftercondenser.

#### *write us for descriptive bulletins*

Available literature on single-stage, multistage and corrosion-resisting types illustrate Elliott's versatility in ejector design and construction for all sorts of

chemical and industrial process applications. Contact your nearby Elliott District Office or write Elliott Company, Jeannette, Pa.

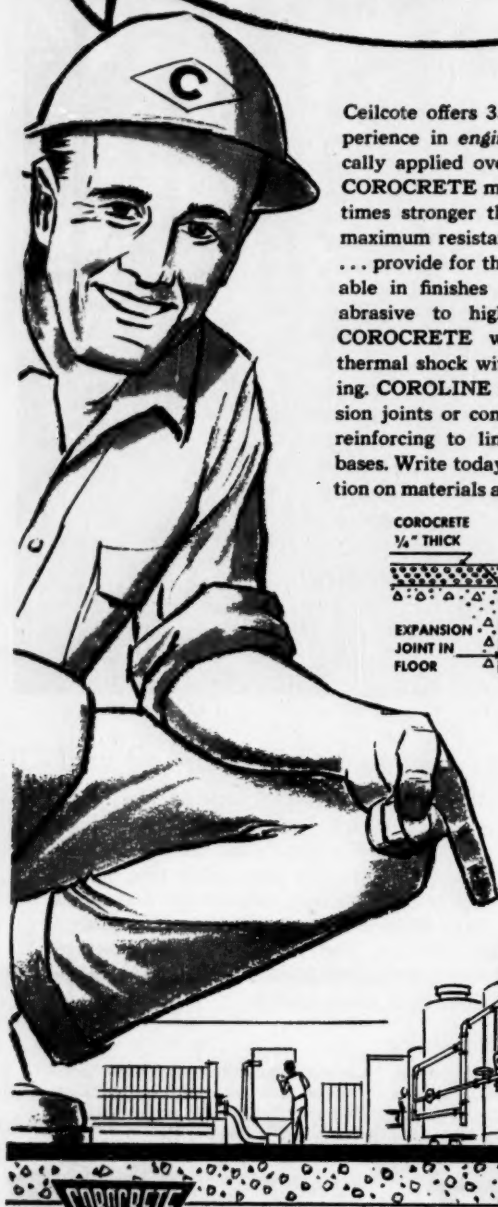
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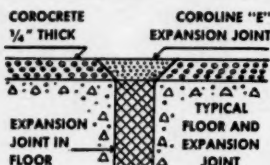


08-2

This  
**CORROSION-PROOF FLOOR**  
was pre-engineered  
by **CEILCOTE!**



Ceilcote offers 33 years of technical experience in *engineering floors*. Scientifically applied over new or old concrete, **COROCRETE** monolithic floors are four times stronger than concrete . . . offer maximum resistance to acids and alkalis . . . provide for thermal expansion. Available in finishes ranging from non-skid abrasive to highly polished surfaces, **COROCRETE** withstands impact and thermal shock without spalling or cracking. **COROLINE** is used to cover expansion joints or combined with glass cloth reinforcing to line trenches and pump bases. Write today for complete information on materials and installation services.



**THE CEILCOTE COMPANY, INC.**

4836 Ridge Road • Cleveland 9, Ohio

**NEW EQUIPMENT . . .**

valves can withstand pressures to 200 psi. at 140 F. Primary application for the valves is for protection of positive-displacement pumps metering corrosive process liquids.—**Milton Roy Co., Philadelphia, Pa. 200D**

**Solenoid valves** having explosion-proof and watertight housings are claimed to be extremely quiet in operation, low in weight and to operate in any mounted position. The two- and three-way direct-acting units are available with an over-all orifice range of 1/8 to 1/2 in.—**Hoke, Inc., Cresskill, N. J. 202A**

**Thermowells** with tantalum tips are available as auxiliary equipment for use in glassed-steel process equipment. Tantalum's innate high heat-transfer characteristics and thinness of wall section make the new thermowells very responsive to temperature change. Present sizes are 3/8 and 1/2 in. I.D., with rated external pressures of 400 psi. and 270 psi., respectively.—**The Pfaudler Co., Rochester, N. Y. 202B**

**Equipment Cost Indexes . . .**

	March 1959	June 1959
<b>Industry</b>		
Avg. of all . . . . .	232.6	234.3
<b>Process Industries</b>		
Cement mfg. . . . .	225.8	227.9
Chemical . . . . .	233.7	235.7
Clay products . . . . .	219.4	221.5
Glass mfg. . . . .	220.7	222.5
Paint mfg. . . . .	224.4	226.6
Paper mfg. . . . .	225.2	227.1
Petroleum ind. . . . .	229.2	231.4
Rubber ind. . . . .	232.0	234.3
Process ind. avg. . . . .	230.1	232.8
<b>Related Industries</b>		
Elec. power equip. . . . .	236.5	246.7
Mining, milling . . . . .	235.2	237.1
Refrigerating . . . . .	262.2	264.7
Steam power . . . . .	219.7	221.8

Compiled quarterly by Marshall and Stevens, Inc., of Ill., Chicago for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124-6 for method of obtaining index numbers; Feb. 23, 1959, pp. 149-50 for annual averages since 1913.

## Take Guesswork Out of Lab Crushing & Grinding

### Sturtevant Design Provides Easy Access for Cleanouts — Returns Complete Sample

In seconds, because of "Open-Door" accessibility, all Sturtevant crushing or grinding parts are exposed for thorough cleanouts. 100% sample return is easy to secure.

Sturtevant laboratory machines are ruggedly constructed — design, based on production models, gives top lab or pilot performance.

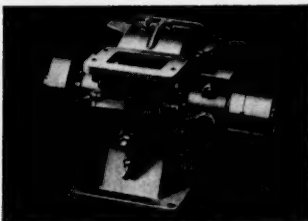
Send for Bulletin No.067, which gives full description of all Sturtevant laboratory machines.



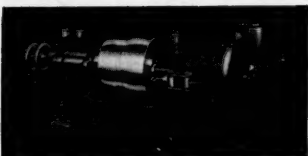
**Lab Crushing Rolls:** Special lab design. Two models: 8 x 5 in. and 12 x 12 in. rolls. Capacities to 10 tph. Both models adjust down to 20 mesh. Tires of high carbon forgings. Automatic feeder, adjustable controls.



**Lab Jaw Crusher:** Crushes hardest rocks at  $\frac{1}{2}$  to  $\frac{1}{4}$  in. settings. Roll jaw action — no clogging. Feed opening 2 x 6 in. Capacity to 1900 lbs. per hr. at  $\frac{1}{2}$  in. setting. Instant adjustment. Manganese jaws, reversible shield.



**Lab Swing-Sledge Mill:** 5 x 6 in. opening takes soft, medium, tough or fibrous feed. Capacity to 1 tph. Fines regulate from 1 in. to 20 mesh. Choice of gratings, hammers (or knives).



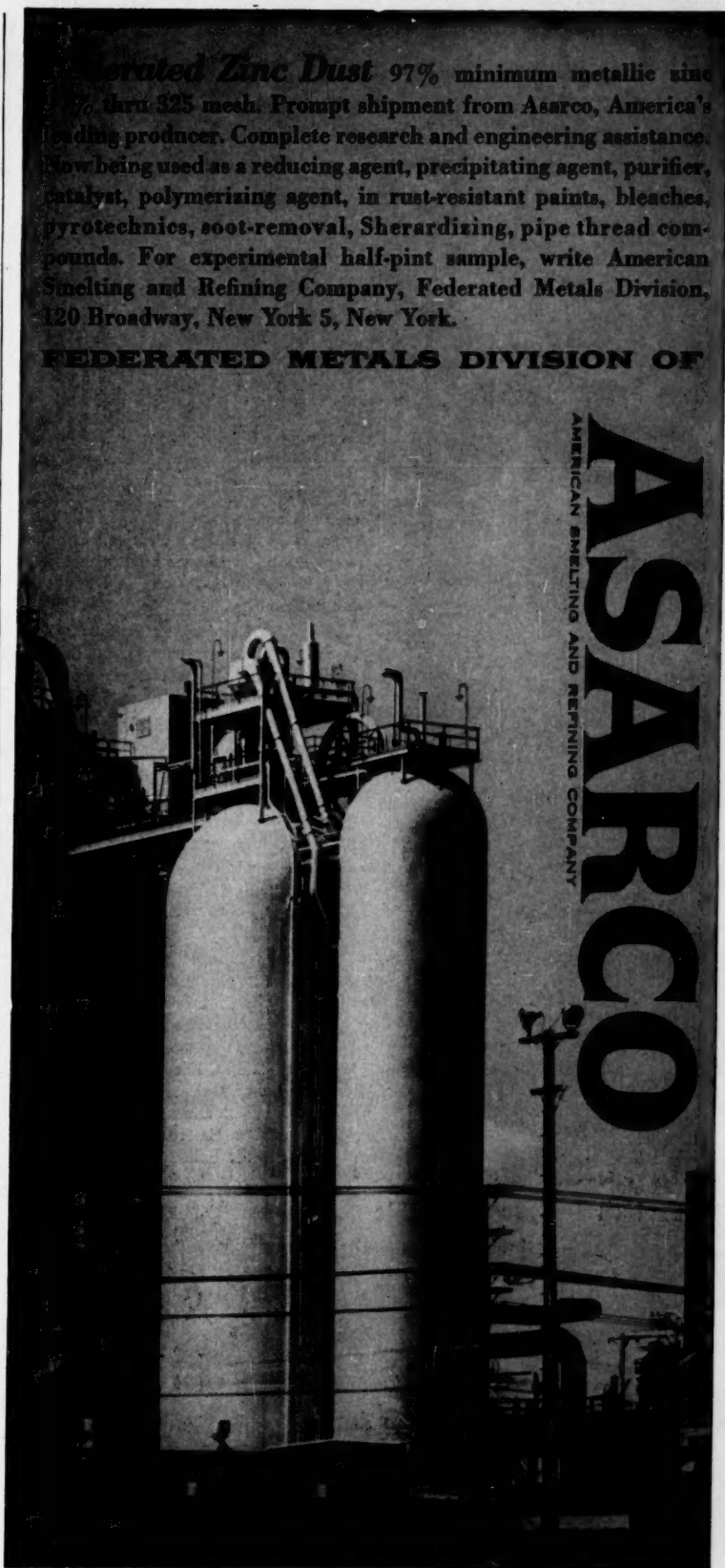
**Sample Grinder:** Disc type grinders for dry, friable soft or medium materials. Three sizes — 6 in., 10 in., and 14 in. take feed as coarse as  $\frac{1}{4}$  in. Produces 100 mesh fines at capacities to 200 lbs. per hr. on largest model. Regulate 10 to 100 mesh. In-operation adjustment.

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MILL COMPANY  
100 Clayton St., Boston 22, Mass.

**Federated Zinc Dust** 97% minimum metallic zinc thru 325 mesh. Prompt shipment from Asarco, America's leading producer. Complete research and engineering assistance. Now being used as a reducing agent, precipitating agent, purifier, catalyst, polymerizing agent, in rust-resistant paints, bleaches, pyrotechnics, soot-removal, Sherardizing, pipe thread compounds. For experimental half-pint sample, write American Smelting and Refining Company, Federated Metals Division, 120 Broadway, New York 5, New York.

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## **GEAR PUMPS and FLUID MOTORS**

129 hydraulic pump and electric motor combinations are available off-the-shelf, for most applications. Outside this broad range, specific customer requirements can be met by drawing on Eastern's vast design resources.

All standard Eastern gear pumps are low in cost, light in weight, compact and reliable. Unique design features and very close tolerances enable each unit to achieve high volumetric efficiencies.

Check the performance ranges in these three major groups — do they meet your needs?

1200 series — up to 1.6 G.P.M. — pressures to 800 P.S.I.

100 series — up to 5 G.P.M. — pressures to 1500 P.S.I.

700 series — up to 9.8 G.P.M. — pressures to 1500 P.S.I.

In addition to these pumps, Eastern also produces a wide range of fluid motors, each capable of delivering a constant torque over a very wide speed range. They provide up to 14.5 ft. lbs. of torque at 1750 R.P.M. For full information on any one of these pumps, pump-and-motor combinations, or fluid motors, consult the Eastern sales engineer — or write for bulletin 810-P.

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## **TECHNICAL**

### **Kinetics Seminar**

*Semenov on cracking:* "Experiments prove that the fully inhibited process is of radical chain nature . . . Objections to these conclusions, raised by Hinshelwood himself, appear vague."

SOME PROBLEMS IN CHEMICAL KINETICS AND REACTIVITY, Volume 2. By N. N. Semenov. Translated from the Russian by Michel Boudart. Princeton University Press. 331 pages. \$4.50 (paper cover).

*Reviewed by Charles N. Satterfield, Professor of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Mass.*

This is Professor Boudart's translation of the second (and final) portion of the book which Semenov wrote originally for a Russian symposium on chemical kinetics and reactivity in 1955.

The volume starts with an analysis of a variety of reactions to show the extent to which each would be expected to proceed by a chain mechanism versus reaction between saturated molecules, or the extent to which photochemical excitation could be expected to contribute to the overall process. By repeated examples, Semenov shows how it is possible to estimate quantitatively the relative rates of competing mechanisms by shrewd

For Satterfield's review of Volume I, see *Chem. Eng.*, Jan. 26, 1959, p. 152.

## BOOKSHELF

J. B. BACON

### by a Master

**Semenov on classic hydrogen-iodine reaction:** "We know that the reaction is not a chain process, but does it occur by direct reaction between the molecules? Another path is possible . . ."

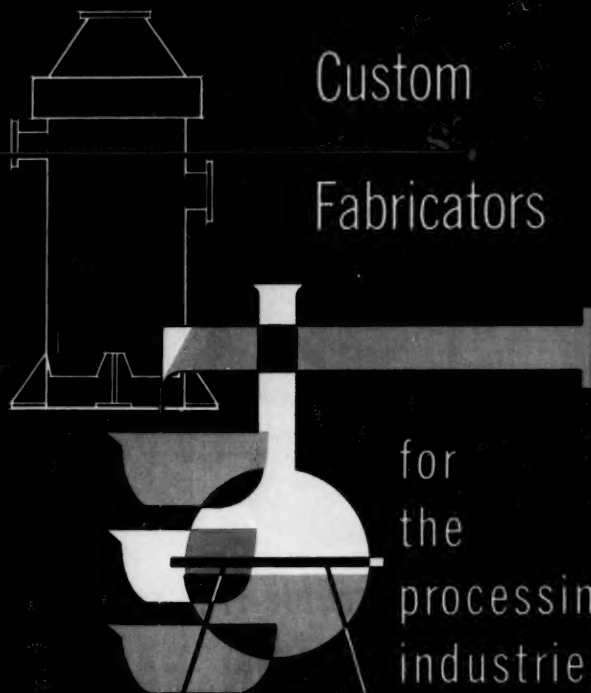
estimates of bond energy, activation energy and steric factors.

The remainder of the book is primarily a new edition of Semenov's famous "Chain Reactions." This treats chain initiation and termination, chain interactions, degenerate branching and various other topics. As illustrations of the general theory, the hydrogen-oxygen explosion limits are treated in great detail as are also the kinetics of phosphorus oxidation and hydrocarbon oxidations.

The principal concepts of Semenov's pioneering theory have not changed in any major way during the last two decades, so although much recent work is included and discussed, it serves primarily to illuminate and clarify various details.

The book is very much up-to-date. The 1955 Russian edition was revised before this English translation was prepared and Volume II even contains a number of additional ideas and corrections received by the translator after Volume I was published.

The style of both volumes is clear, concise and pithy. Although it is presumed that the reader has a background corresponding, say, to a semester's study of chemical kinetics, most of the material is not difficult to follow. The presentation is es-



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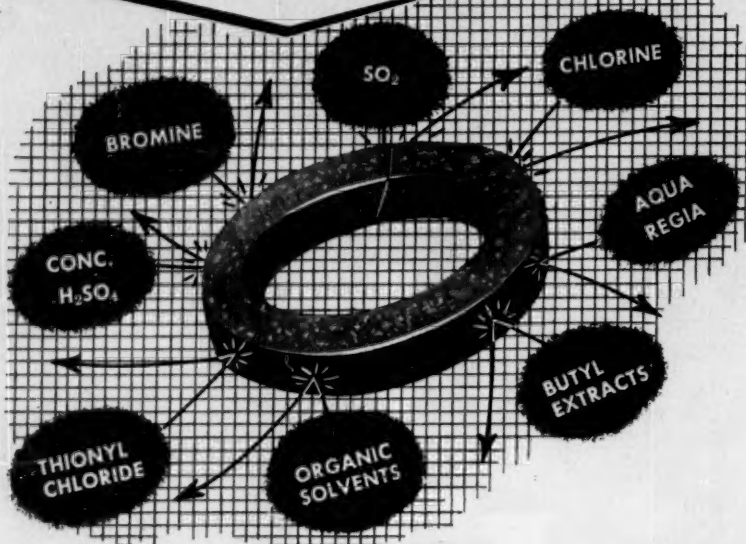
Since 1910, The Boardman Co. has been selected by leaders in the chemical processing industries for dependable, precision custom fabrication. Boardman will apply the same superior workmanship and design to your processing equipment needs, too. Write or call today.

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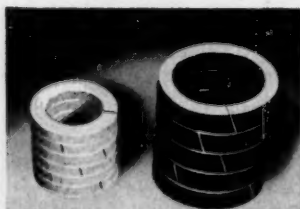
P. O. BOX 1157 • OKLAHOMA CITY, OKLA.

**If you pump these  
corrosives...**



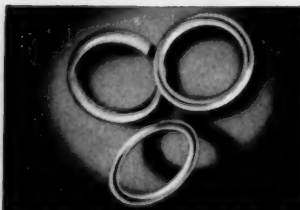
## **Get months of Trouble-Free service with CHEMPRO TEFLON PACKINGS**

If your pumps and valves handle highly corrosive industrial chemicals, CHEMPRO TEFLON PACKINGS will drastically cut packing replacement and maintenance costs. CHEMPRO Packings last for many months under corrosive conditions which make ordinary packings useless in days or even hours. They stop leakage by providing a tight seal at only slight gland pressure, and their very low coefficient of friction often makes lubrication unnecessary.



### **TEFLON® PLASTIC STUFFING BOX PACKING**

Ideal for either centrifugal or reciprocating pumps operating at speeds up to 3600 R.P.M. handling corrosives at temperatures from -118° F. to 525° F. Style No. 101 composed of 94% shredded Teflon and chemically inert graphite as a friction reducer. Style No. 201 same as No. 101 except that mica is used as friction reducer. Both styles made to fit every size stuffing box on standard process equipment.



### **TEFLON V-TYPE PACKINGS**

For reciprocating pumps and hand, air and motor operated valves handling corrosive materials. Lips of very sensitive pressure rings expand proportionately to increased operating pressure thereby preventing leakage. Suitable for temperatures from -150° F. to 550° F. Unsuitable for centrifugal or rotary pumps. Supplied in bulk or in complete sets to fit specific stuffing boxes.

Chemical & Power Products engineers are packing and gasket specialists with complete fabricating facilities to meet your specific requirements. Write for our complete Teflon Packing and Gasket Catalog.



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The Original Fabricators of Teflon Packings and Gaskets

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### **BOOKSHELF . . .**

essentially all within the framework of classical collision theory. However, chemical engineers who, like this reviewer, have sometimes been baffled by the more arcane reaches of the absolute theory of reaction rates, will welcome the two brief and admirable appendixes which review the basic concepts and assumptions involved in this approach and its present limitations.

The completed translation now available provides a fine way of sitting in on a seminar on kinetics by a provocative and stimulating master.

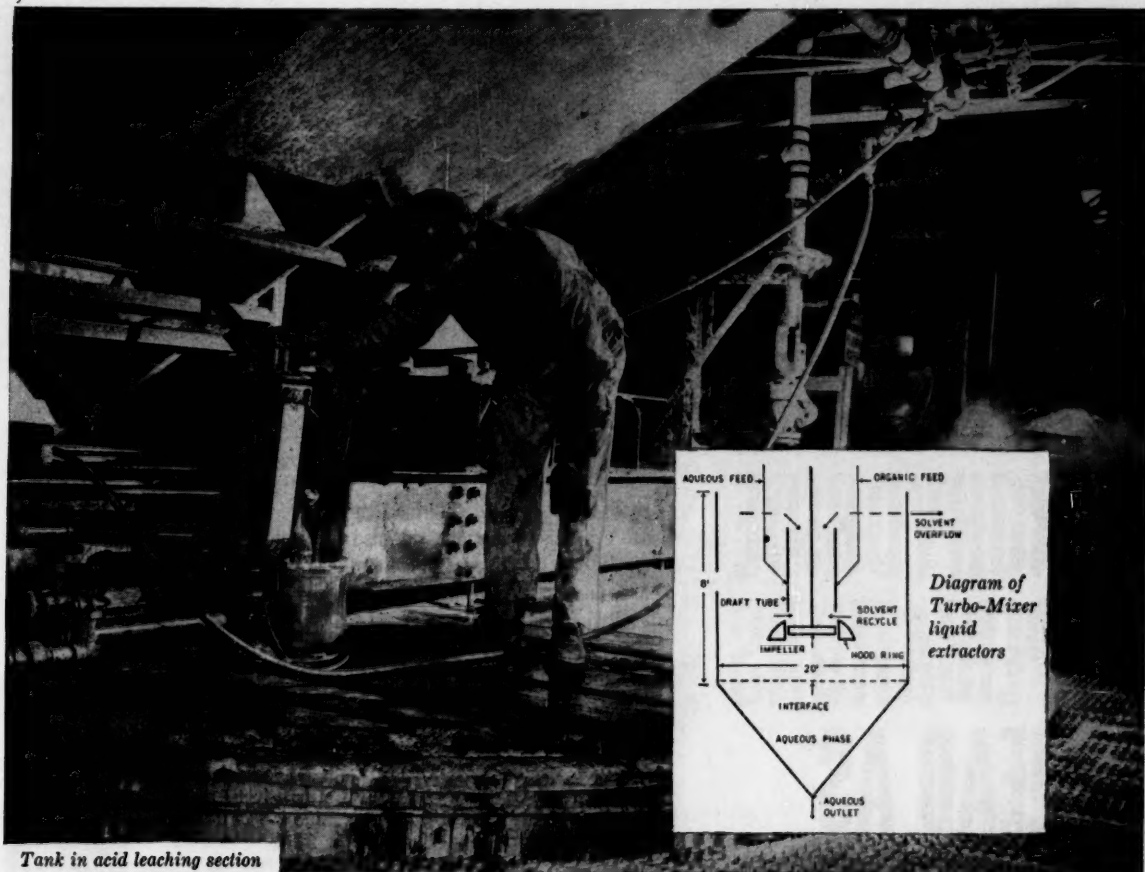
### **A Welcome Work**

INTERNATIONAL COMMITTEE OF ELECTROCHEMICAL THERMODYNAMICS AND KINETICS — PROCEEDINGS OF THE EIGHTH MEETING. Butterworth & Co. (Canada), Ltd. 497 pages. \$19.

*Reviewed by George J. Janz, Rensselaer Polytechnic Institute, Department of Chemistry, Troy, N. Y.*

The International Committee of Electrochemical Thermodynamics and Kinetics is a group with representation from more than twenty nations. The complete proceedings of the eighth meeting illustrate interest in common problems and collaboration on agreed programs by this group of research workers. The reports of five commissions (nomenclature, experimental methods, electrochemical diagrams, corrosion and protection, batteries and accumulators, and two study groups dealing with electrochemical kinetics and semi-conductors) form the central theme of the Madrid meeting.

About 60 research papers as given at this meeting appear in this volume. In addition to the various electrochemical techniques and studies in the areas mentioned above in the conventional range of temperatures, an excellent account of the techniques for electrode processes up to 1,000 C. and the silver-silver chloride reference electrode both in molten salts appear in this volume. Publication of some of the papers and reports in this



Tank in acid leaching section

## VITRO URANIUM HANDLES A WIDE VARIETY OF URANIUM MINERALS WITH TURBO ON THE JOB

When VITRO URANIUM COMPANY of Salt Lake City embarked on a modernization program, they called on GENERAL AMERICAN to assist in the design of the most modern mill possible.

Heart of the plant is the extraction system, and here, GENERAL AMERICAN Turbo-Mixers proved to be key equipment, in both the leaching and liquid extraction sections.

VITRO URANIUM processes a wide variety of uranium minerals which require highly versa-

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**GENERAL AMERICAN**  
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**FOR: Achievement In Equipment**  
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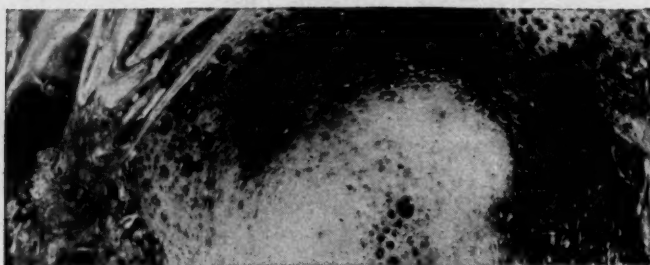
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 Process Equipment Division  
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# BOROHYDRIDE APPLICATIONS SPREAD AS MHI EXPANDS PRODUCT FORM AVAILABILITY

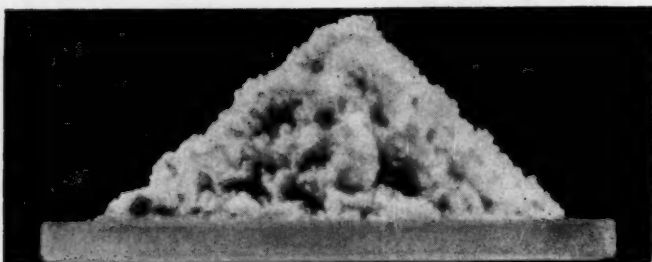
**SWS — Stabilized Water Solution**, a new form of sodium borohydride available in commercial quantities at a price less than half of the pure material. Sodium Borohydride-SWS is a stable, aqueous caustic solution. The sodium borohydride content is about 12 weight percent and is ideal for use in cleaning up small amounts of carbonyl and peroxides in organic products.



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## BOOKSHELF . . .

volume in the original French and German, as well as English, captures the international nature of this meeting.

The book is a welcome addition to the works in electrochemistry.

## BRIEFLY NOTED

**DISPOSAL PROBLEMS OF CHLORINE PLANTS: FINAL REPORT**, PB 151-640. 172 pp. *Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.* \$3. Contains detailed operating instructions for methods of treating brine to remove contaminants prior to electrolysis.

**EQUATIONS OF STATE FOR HYDROCARBONS**. 183 pp. *American Petroleum Institute, 50 W. 50 St., New York 20, N. Y.* \$7.80 for API members, \$13 for nonmembers. Third volume in a series emanating from API Research Project 37 at California Institute of Technology; contains review of development of equations of state and discussion of recent achievements in prediction of volumetric behavior.

**SURVEY OF SOLUBILITY DIAGRAMS FOR TERNARY AND QUATERNARY LIQUID SYSTEMS**. 42 pp. By D. M. Himmelblau, B. L. Brady and J. J. McKetta, Jr., *Bureau of Engineering Research, University of Texas, Austin 12, Tex.* \$2. Surveys literature of water and organic liquid systems published prior to June 1958 in periodicals, textbooks and industrial publications.

## MORE NEW BOOKS

**S-TRIAZINES AND DERIVATIVES** (Chemistry of Heterocyclic Compounds, Vol. 13). By Edward M. Smolin and Lorence Rapoport. Interscience. \$30 single, \$28 subscription.

**LIQUIDS AND LIQUID MIXTURES**. By J. S. Rowlinson. Academic Press. \$12.

**SYMPOSIUM ON MATERIALS RESEARCH FRONTIERS**. 48 pp. *American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.* \$2. Gives papers on materials research given at symposium in Boston, June 1958.

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## LETTERS:

### Pro: Porous Plastics

*Sir:*

We received quite a reaction from your article on porous plastics which appeared in the June 29 *Chemticator*. A large number of inquiries have come in, which certainly indicates that there is a great deal of interest in this type of material.

Our development activities appear to be right on schedule, and we may be in a position late this year to do the more comprehensive plant-process story you have suggested.

HOWARD J. STRAUSS  
ESB-Reeves Corp.  
Philadelphia, Pa.

### More on Work Study

*Sir:*

I found most interesting the article in your June 15 issue (pp. 200-206) which was based on our booklets entitled "Notes on Work Study."

In case your readers might want to obtain the original booklets, they are available from us at these prices:

• No. 1, "How to Start," 2/6d plus postage.

• No. 2, "Some Results," 2/6d plus postage.

• No. 3, "Case Histories from Smaller Firms and Individual Plants in the Chemical Industry," 4/-d plus postage.

M. VIVIANI  
Assn. of British Chemical  
Manufacturers  
London, W.C.2, England

### Librarian Likes It

*Sir:*

Congratulations on your solution to the problem of satisfying the individual reader who wishes to remove particular articles from your magazine while at the same time making it possible for the librarian to bind it. Our copies of *Chemical Engineering* for June 15 have circulated for

## PRO & CON

C. H. CHILTON

five weeks, and we are pleased to find that they are holding up as well as ever.

We earnestly hope that your very excellent solution will be followed by other magazine publishers, and the problems associated with perforated pages will cease to exist.

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J. W. GLENN

M & C Nuclear, Inc.  
Attleboro, Mass.

### Packed-Bed Demisting

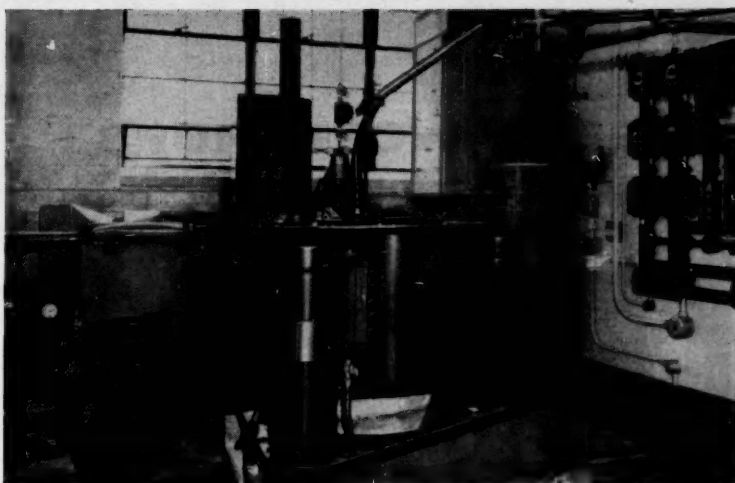
Sir:

We found Mr. Massey's article on demisting in your July 13 issue (pp. 143-146) not only interesting, but a practical contribution to chemical engineering technology.

Regarding the studies made by Stauffer Chemical Co., we would like to add a few comments on the subject of packed beds for mist elimination:

In the table summarizing "Comparative Filter Performance Data," it is not surprising to find that mist elimination efficiency dropped at 20 ft./sec. in the Berl saddle bed. The measured pressure drop of  $3\frac{1}{2}$  in.  $H_2O$ /ft. would indicate flooding conditions. Thus, as Mr. Massey indicates, re-entrainment would probably occur.

We would also like to call to your readers' attention a report of similar work. Wilhelm Pfannmüller (*Trans. Inst. Chem. Engrs.*, Vol. 32, 1954, Supplement, pp. 151 ff.) gives the characteristics of Pall rings (patented shape of Badische Anilin und Soda-Fabrik) as mist elimi-



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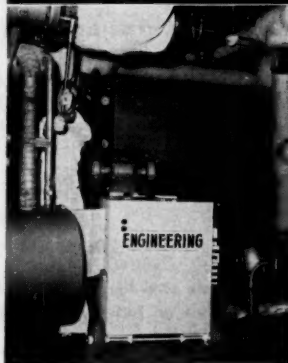
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#### PRO & CON . . .

nators. Giving as an example the experiences in a contact sulfuric acid plant, he reports that operating velocities were doubled over those permissible with Raschig rings of the same size. Moreover, the pressure drop was only half as great.

In the same plant, 1-in. Raschig rings were used to dry the air for sulfur burning, using contact sulfuric acid. Carryover of acid was so great as to require overhauling of the blower after three to five months' running time. Substitution of Pall rings eliminated this condition, even though the load was increased by 30%.

Similarly striking results were obtained in alcohol rectifications, where carryover was reduced by over 85%, with a 60% reduction in pressure drop.

Metal Pall rings, having considerably higher free space, would permit even greater velocities. Thus, with 1-in. stainless steel Pall rings, flows of 15-20 ft./sec. could be handled with a pressure drop of 1 in. H<sub>2</sub>O/ft.

It is important to note that the fouling tendencies of this type of packing would also be considerably less than with closely knit wire-mesh filters.

C. S. BROWN  
United States Stoneware Co.  
New York, N. Y.

Sir:

In the subtitle to Mr. Massey's article you have taken undue liberty with our property. "Demister" is the registered trade mark for our wire-mesh mist eliminators.

OTTO H. YORK

Otto H. York Co.  
West Orange, N. J.

#### **Pro: Articulate Engineers**

Sir:

These comments are made on Monroe E. Spaght's article, "Industry Speaks Its Mind on Engineering Education," which appeared in your June 29 issue (pp. 120-126).

I heard Mr. Spaght's original talk and was much impressed by what he said. I was particularly impressed by his comments that engineers are not articulate.

We teachers have been beaten over the head so much regarding this that we are about ready to fight back.

If one were to examine the College Entrance Examination Board scores for men who have chosen engineering as a career, he would find in almost every case that the verbal score is lower than the mathematics score—sometimes by as much as 100 points. This does not mean, however, that the verbal score does not count, nor that a below-average verbal score is acceptable. A high degree of comprehension is needed in engineering, so a good verbal score is necessary.

When engineers are castigated for not being articulate, they usually are being compared with men who had high verbal scores to start with and major in verbal fields. But among themselves—in seminars, meetings and conferences, where they are on familiar ground technically—engineers turn out to be quite articulate. Whether or not one is articulate depends pretty much on his familiarity with the subject, and to make the broad accusation that engineers are not articulate is to my mind somewhat out of context.

Let's stop making engineers feel self-conscious and inferior. They are articulate.

WALTER J. SEELEY

Duke University  
Durham, N. C.

### Difficult Reporting

Sir:

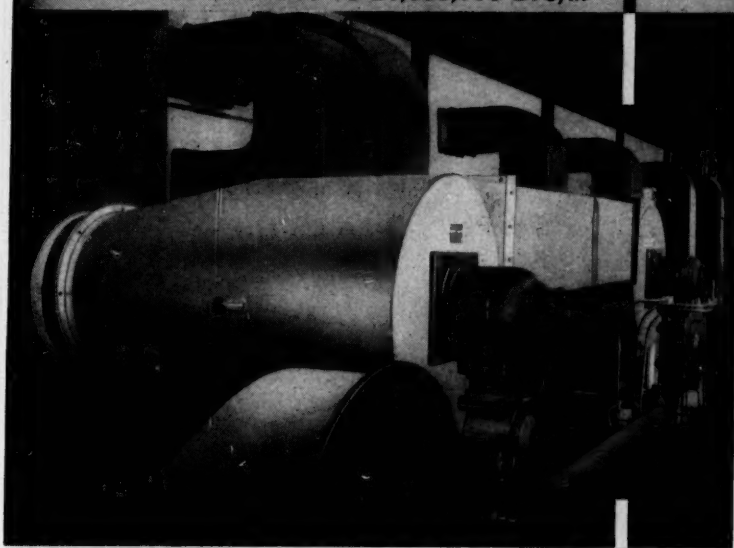
Your May 18 Report, "Chemicals From Petroleum" (pp. 151-168), is particularly well done. Congratulations on a difficult piece of reporting, presented very nicely.

L. I. BLENNERHASSETT  
C. F. Braun & Co.  
Alhambra, Calif.

Your comments and opinions are important. Send them to Editor, Chemical Engineering, 330 West 42nd St., New York 36, N. Y. They'll be welcomed.

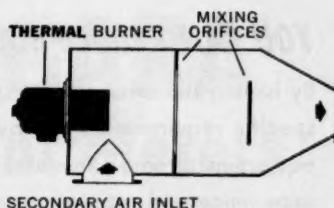
## THERMAL'S PACKAGED AIR HEATERS

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Extremely versatile design permits the THERMAL Type CA heater to be used in a wide variety of installations and with either gas, oil or combination firing. Shown here is a tunnel dryer installation of the Edgar Plastic Kaolin Co., Edgar, Florida. THERMAL CA air heaters with #7028 burners provide 4,000,000 BTU/hr each using #2 fuel oil. These air heaters are equally adaptable to kilns, ovens, spray dryers and many other installations where products of combustion may be mixed with the air.



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WRITE FOR BULLETIN #104

THERMAL'S all-metal, welded construction keeps maintenance costs at a minimum. CA air heaters are supplied as complete "package" installations with outputs ranging from 200,000 BTU/hr to over 20,000,000 BTU/hr at all pressure levels.

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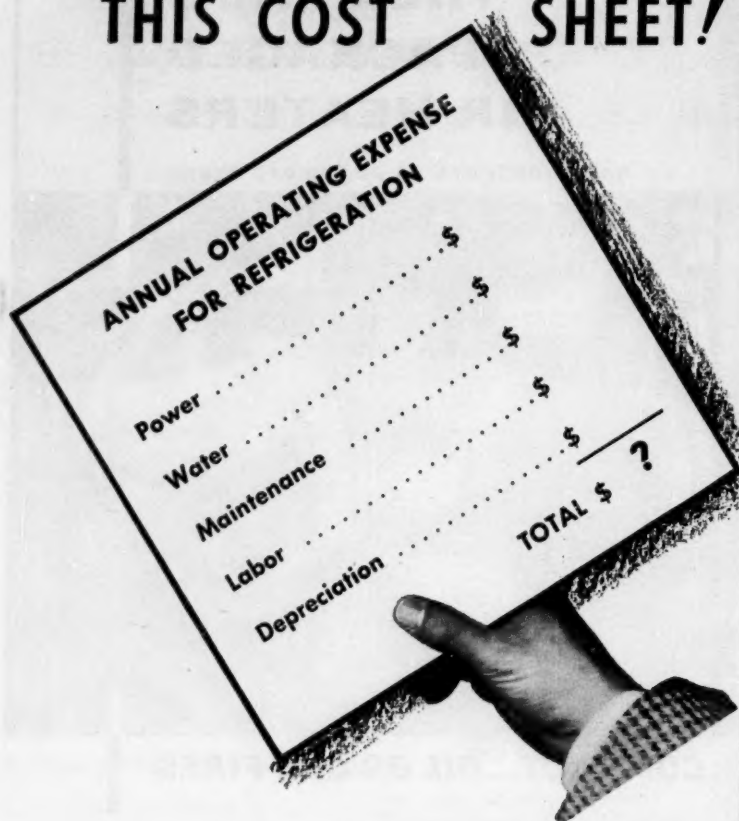


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## READER SERVICE . . .

## TECHNICAL

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### Chemicals

**Active Aluminas.....**A copy of the new technical brochure "Kaiser Aluminas" is now available on request. Contains specification on any special alumina product.  
195 \*Kaiser Aluminum & Chemicals

**Adhesive.....**2 p. brochure describes R-703, a fast acting solvent type adhesive for joining polystyrene to polystyrene. Several methods of application are described.  
214A Bee Chemical Co.

**Antiozonants.....**An effective laboratory procedure for screening organic compounds as potential antiozonants has been recently developed. Information.  
28-29e \*American Cyanamid Co.

**Antistatic Agent.....**Catanac SN is ideal for use wherever undesirable static charge is present. Prevents accumulation on a wide variety of substances.  
28-29a \*American Cyanamid Co.

**Activated Charcoal.....**Acts as a molecular sponge, purifies air, gases, liquids—recovers solvents—removes odors & impurities, etc. Write for Bulletin J-102.  
R238 \*Barnebey-Cheney

**Carbon Dioxide.....**CO<sub>2</sub> comes in a variety of forms & quantities ranging from 50-lb. cylinders & dry ice to 24- & 30-ton tank cars for unloading to your process.  
184 \*Olin Mathieson Chem. Corp.

**Catalysts.....**Are available in 6 forms: tableted, extruded, granular, spheres, flakes & powders. Technical assistance and booklet are available.  
55 \*The Harshaw Chemical Co.

**Chemical.....**Bul. F-40392 contains data on physical & physiological properties of N,N,N',N'-tetramethyl-1, 3-butanediamine. Available in 55 gal. drums.  
91b \*Union Carbide Chemicals Co.

\* From advertisement, this issue

## LITERATURE

E. M. FLYNN

**Chemical Analysis.**.....2 p. data sheet outlines methodology for continuous determination of sugars down to ppm in waste waters in refineries. Includes flow diagram.  
215A Technicon Controls, Inc.

**Chemicals.**.....The 1959 Physical Properties of Synthetic Organic Chemicals—a comprehensive description of the properties & uses of more than 400 chemicals.  
91c \*Union Carbide Chemicals Co.

**Dyes.**.....8 p. circular G-806 deals with properties and applications of Indanthrene Corinth B Infra Paste, a vat dyestuff made as a straight product for the first time.  
215B General Aniline & Film Corp.

**Epoxy Resin.**.....Catalog describes the high reliability of TC-459 epoxy resin for sealing and reinforcing electrical connectors.  
215C

Electronic Production & Development

**Ethylene Oxide.**.....A 20-page booklet contains recommendations for sampling, handling, unloading, and storing, plus ordering & shipping information.  
91d \*Union Carbide Chemicals Co.

**Flavor, Odor Chemicals.**.....Wide variety of flavors, spices, certified colors, sauce bases, aromatic chemicals and cover odors are listed in 36 p. catalog.  
215D Florasynth Laboratories

**Grease.**.....Mobilplex is a Multi-Service Grease with unique Calcium EP Complex. Provides maximum protection against wear, rust, wash-out and heat. Full details.  
6-7 \*Socony-Mobil Oil Co.

**Hard Carbide Alloys.**.....Can be supplied as standard rectangular blanks, discs, rods, tubes, etc. Can be extruded, pressed, machined or ground. Information.  
R251 \*Kennametal Inc.

**Lubricants.**.....Book discusses organized lubrication from management's point of view. Also discusses methods that help raise production, extend parts life, cut downtime.  
173a \*Texaco, Inc.

\* From advertisement, this issue

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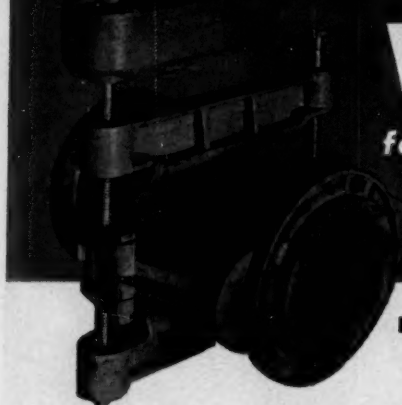
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## LITERATURE . . .

**Lubricants.**.....Ucon lubricants, DLB series, are available now in tank car quantities, drums, or in economical compartment tank car or truck shipments. Tech. Bul. 91a \*Union Carbide Chem. Co.

**Metallic Nitrates.**.....Available in purified or technical grades for general manufacturing use . . . in reagent grade for more exacting requirements. Technical Data. 69 \*Allied Chem., General Chem. Div.

**Molecular Sieves.**.....12 p. bulletin F-1194 A describes use and advantages in the manufacture of latent curing aids in rubber & plastics. Includes several full-page charts. 216A Linde Co.

**Perfume Chemicals.**.....9 p. bulletin describes a new odor-producing ingredient for reconstituted essential oils. A synthetic ketone called Nerone, it has a fresh, leafy odor. 216B Givaudan-Delawanna, Inc.

**Phosphorus-Sulfur Containing Compound.**.....Malathion-base insecticides are used to protect fruits, vegetables, ornamentals, livestock and household pets. 28-29d \*American Cyanamid Co.

**Polyester Pre-Mix Molding Compound.**.....Laminac offers high impact strength, excellent flame & heat resistance, low moisture absorption, good electrical properties. 28-29b \*American Cyanamid Co.

**Polyvinylpyrrolidone.**.....8 p. booklet TA-52 describes PVP effectiveness in reducing toxicity and sensitivity problems inherent in phenols and other compounds. 216C Antara Chemicals

**Resin.**.....Accostrength Resin 2386 has ability to bring about greater dry strength with little change in bulk or porosity. Valuable in the manufacture of printing papers. 28-29c \*American Cyanamid Co.

**Resin.**.....Epon 1002 is a new grade of resin that is hard & free-flowing at elevated temperatures. Complete information, including technical bulletin SC:58-107 offered. Cover \*Shell Chemical Corp.

**Rubber, Urethane.**.....8 p. describes Neothane castable polyurethane rubber for the information of design, development and research engineers. Castable in unusual shapes. 216D Goodyear Tire & Rubber Co.

**Solvent.**.....Laktane is perfect for fast drying lacquers and has a remarkably clean odor. Further information or technical assistance on request. 95 \*Esso Standard Oil Co.

**Sucrose Derivative.**.....16 p. brochure N-105 describes use and effect of sucrose acetate isobutyrate as a modifying extender in a variety of lacquers and melt coatings. 216E Eastman Chemical Products

**Sulfur Dioxide.**.....Bulletin I-173 covers safe handling during transport, storage or use. Includes sections on containers, unloading care of equipment, safety precautions. 216F Monsanto Chemical Co.

**Synthetic Gums.**....with available viscosities ranging from 10 cps. to 15,000 cps. Methocel shows capabilities as thickeners, stabilizers, etc. A 60-pg. Methocel Book. 14-15 \*The Dow Chemical Co.

\* From advertisement, this issue

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Twin-tip pointer enables observer to read "dead-on" by lining up twin tips like gun sight.

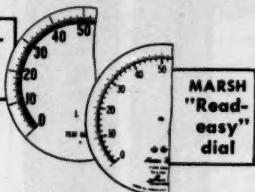


Mirror dial also insures accurate "dead-on" reading.



"Non-parallax" dial has Plexiglas insert that assures accurate reading even when read at angle.

Conventional dial



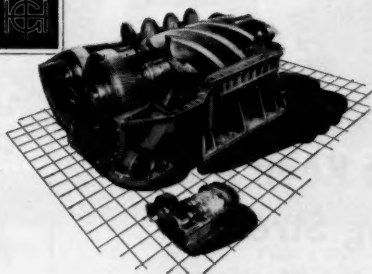
New "Read-easy" dial (patent pending), as illustrated above, assures reading accuracy in keeping with indicating accuracy. Also note three advanced means of reading available in all "Master-test" gauges: twin-tip pointer, mirror dial, and "non-parallax" dial as shown opposite.

Sizes 4 1/2", 6", 8". All standard pressure ranges 0-15 psi to 0-30,000 psi, vacuum and compound.

Ask for new 20 page bulletin covering all details

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Division of Colorado Oil and Gas Corporation  
Marsh Instrument & Valve Co., (Canada) Ltd.  
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- Oil-Free Operation
- No Metal-to-Metal Contact of rotating elements
- Over 400 Units in Operation handling air, hydrocarbons, and many other gases
- Suction Volumes 350 to 15,000 cfm
- Compression Ratios up to 1:4 for single stage and 1:10 for two-stage units



**GUTEHOFFNUNGSHÜTTE**

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REPRESENTATIVES: **THE FORAM CORPORATION**

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MODEL 8-S  
STAINLESS STEEL



MODEL EFS  
18" X 12" SQUARE



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WRITE FOR  
CATALOG 58

JACKETED  
MODEL 10



MODEL EFS-B  
PILOT OPERATIONS



MODEL EW  
POLISHING TYPE



MODEL ECS  
CYLINDER  
DISK



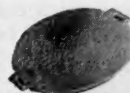
MODEL EBW  
PORTABLE



MODEL EUS  
CAPACITY TO 80 GPM



MODEL EUR  
NON-METALLIC



**ASBESTOS  
FILTER  
SHEETS**  
Various Sizes

Ertel Asbestos Filter Sheets for ultra polished brilliance are used for many fine perfumes and cosmetics. Available in 10 grades to fit all standard filters. Write regarding samples for superior result tests in your filter.

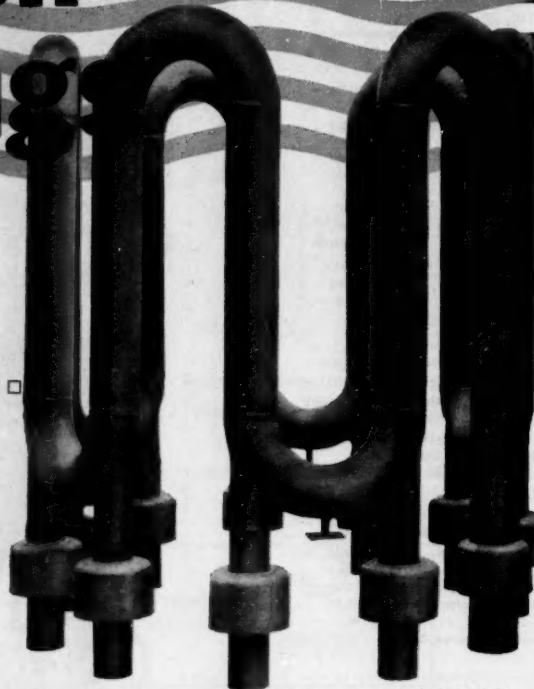
**ERTEL**

**ERTEL ENGINEERING CORPORATION**  
Liquid Handling Equipment Manufacturers Since 1932  
40 FAIR STREET KINGSTON, N. Y.

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are  
HOT.

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on

Duraloy



A design of the  
A. F. Holden Co.,  
Detroit, Mich.

## Castings that Keep their Load-Carrying Strength at High Temperatures

This "immersion type radiant heater" is typical of the high reliability castings turned out by DURALOY. Centrifugally cast tubes with *UNIFORM* wall thickness...for longest service life. Static cast collars and shell molded bends...typical of DURALOY versatility.

For your high alloy casting requirements check with DURALOY...our long experience, ultra-modern foundry and up-to-the-minute test equipment will be helpful in solving your problems. For more information ask for Bulletin No. 3150 G.



**DURALOY Company**  
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EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.  
ATLANTA OFFICE: 76-4th Street, N.W.  
CHICAGO OFFICE: 332 South Michigan Avenue  
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

### LITERATURE . . .

**Tetrahydrofurfuryl Alcohol**.....offers many advantages in dyeing. Samples of tetrahydrofurfuryl alcohol and a copy of Bulletin 206 are available on request.  
87 \*The Quaker Oats Co.

**Tridecyl Alcohol**.....is the basic ingredient of dtridecyl phthalate, a new high performance plasticizer. Further information about Tridecyl Alcohol in Bul. No. 20.  
71 \*Enjay Company, Inc.

**Urethane**.....Three bulletins describe a new liquid urethane resin prepolymer formulated with a halogenated hydrocarbon to produce rigid foams good for heat insulation.  
218A Thiokol Chemical Corp.

**Urethanes**.....30 p. booklet reprints ACS paper, "The Development of Cast Urethane Elastomers for Ultimate Properties," by K. A. Pigott et al. with charts and graphs.  
218B Mobay Chemical Co.

**Vinyl Acetate**.....Bulletin SD-75 on safe handling techniques for industrial users may be obtained for 30¢. Covers physical properties, etc.  
218C Manufacturing Chemists' Assn.

### Construction Material

**Aluminum Bus Conductor**.....features low material cost, low installation & maintenance costs. Complete information in Handbook which is offered.  
167 \*Aluminum Co. of America

**Castings**.....Ultra-modern foundry and up-to-the-minute test equipment will be helpful in solving your problems. Complete information in Bulletin No. 3150 G.  
218 \*The Duraloy Co.

**Coatings**.....Amercoat No. 78 offers dependable, all-around protection. Illustrated copies of comparative tests of Coal Tar Epoxy Coatings is now available.  
181 \*Amercoat Corporation

**Diatomites**.....Hyflo Super Cel, Celite 545 & Super Floss have distinctive particle size distribution. Assistance with specific filtration or mineral filler problems offered.  
161 \*Johns-Manville

**Floor, Corrosion-Proof**.....Corocrete monolithic floors offer maximum resistance to acids & alkalis. Information on materials & installation services offered.  
202 \*The Celcote Co., Inc.

**Fused Quartz**.....Vitresol is available in an unusually wide variety of types & sizes. Offers outstanding electrical properties. Tech. Data.  
R219 \*Thermal American Fused

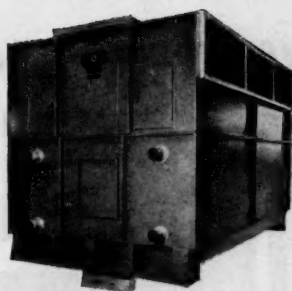
**Heads**.....Spun or pressed heads in diameters from 9" to 19" . . . in gages from 3/16" to 6" . . . in all shapes & a complete range of ferrous & non-ferrous metals. Details.  
49 \*The Colorado Fuel & Iron Corp.

**Insulations**.....made of many materials in many forms and in a wide variety of styles, densities & sizes. Solve every insulation problem, hot or cold. New catalog.  
115 \*Baldwin-Ehret-Hill Inc.

\* From advertisement, this issue

## This Self-Contained Fluid Cooling System

... gives most  
accurate temperature  
control



Applied in cooling industrial machines or processes to temperatures approaching the ambient wet-bulb, the NIAGARA Aero HEAT EXCHANGER is independent of any more than a nominal water supply or disposal. The coolant system is a closed one, free from dirt and maintenance troubles.

Heat is removed from your process at the rate of input, giving you precisely the temperature you require and assuring the quality of your product. Heat may be added to prevent freezing in winter or

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Heat is rejected outdoors. Only the little water evaporated on the cooling coils in the air stream, or discharged to prevent hardness build-up, is consumed.

Niagara sectional construction saves you much installation and upkeep expense, gives full access to all interior parts and piping. Your equipment always gives you full capacity and "new plant" efficiency.

Write for Niagara Bulletin No. 132 for complete information

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## STAINLESS STEEL

### "MNH" FLEXIBLE CONNECTORS

A NEW stock answer to pipeline problems caused by rigid connections.

- Dampens Vibration
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- Permits Offset Movement
- Absorbs Expansion

With ALLFLEX Stainless Steel Connectors you get:

- CORROSION RESISTANCE . . . plus
- PRESSURE RESISTANCE . . . plus
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- FLEXIBILITY

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Non-absorbent, non-catalytic, non-porous, immune to extreme electrical, thermal and chemical conditions. Many sizes and types in stock. Prompt delivery for special sizes.

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## SHRIVER Vertical Leaf Pressure Filter offers outstanding operating efficiency

- For large volume clarification
- For high filtration efficiency
- For quick discharge of solids and easy cleaning

The Shriver "HTVL" horizontal tank vertical leaf pressure filter provides the maximum in performance. It incorporates the most advanced design features to assure perfect clarity of filtrate; uniform, reasonably dry cake; easy accessibility for cleaning and compactness.

The filter is available in 27 standard combinations of tank size and number of filter leaves. Leaf assembly, filtrate discharge and leaf carriage simplify operation.

There's a Shriver "HTVL" filter unit for your needs—now or projected.



Send for  
handy Bulletin 146  
which tells all you'll  
want to know about the  
filter for better filtration.

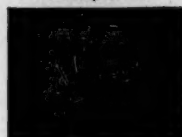
**T. SHRIVER & COMPANY, INC.**

802 HAMILTON STREET • HARRISON, N. J.

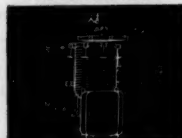
SALES REPRESENTATIVES IN: Atlanta, Ga. — Buffalo, N. Y. — Chicago, Ill. — Detroit, Mich. — Houston, Tex. — Los Angeles, Cal. — St. Louis, Mo. — San Francisco, Cal. — Montreal, Que. — Toronto, Ont. — Mexico City, Mex.



Filter presses



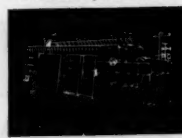
Horizontal tank,  
vertical leaf filters



Vertical tank,  
vertical leaf filters



Vertical tank,  
horizontal plate filters



Plastics polymerizers  
and slobbers



Continuous thickeners



Filter media  
textile and metal



Diaphragm pumps

## LITERATURE . . .

**Linings.**.....Cementable Teflon is available in continuous tapes .005" through .006", through 24" wide; & in sheet through 48" x 48". Catalog AD-158. 197 \*The Garlock Packing Co.

**Nickel Alloys.**.....for high-temperature & low temperature filtering. New booklet "Handling Fluorine and Fluorine Compounds with Inco Nickel Alloys" offered. 104a \*The International Nickel Co., Inc.

**Packings.**.....The complete Teflon Packing and Gasket Catalog is available. Complete fabricating facilities to meet your specific requirements. 206 \*Chemical & Power Products, Inc.

**Refractories.**.....There is a wide range of products, each with a combination of properties. A copy of "Super Refractories by Carborundum" is now available. 10 \*The Carborundum Co.

**Stainless Steel.**.....Complete information on the properties & fabrication of Armco 17-14 Cu Mo stainless. Offers excellent high temperature properties. 175 \*Armco Steel Corp.

**Steel.**.....Union 20-S is a new source for pipe, tube, strip, sheet, plate, bar, & wire. Complete information contained in Bulletin 20-S. Send for your copy. 101 \*Union Steel Corp.

**Titanium.**.....the light, strong, corrosion-resisting metal which is the answer to difficult corrosion problems. Information on titanium in new profitable applications. 159 \*Union Carbide Metals Co.

**Wire Cloth & Filter Cloth.**.....to your exact requirements in rolls or cut pieces or in fabricated components. Catalog outlines all types. TL225 \*Multi-Metal Wire Cloth

**Zinc Dust.**.....used as a reducing agent, precipitating agent, purifier, catalyst, polymerizing agent, in rust-resistant paints, bleaches, etc. Experimental half-pint sample. 203 \*American Smelting & Refining Co.

**Zirconium.**.....offers extremely long service life. Technical Data Sheets on "Physical and Mechanical Properties of Zirconium" are available on request. 4 \*Mallory-Sharon Metals Corp.

## Electrical & mechanical

**Caster & Wheels.**.....with a wide choice of treads suited to all types of floors. Manual describes over 4000 types of casters and wheels that are available. R229 \*Darnell Corp.

**Couplings.**.....Basic type F Steelflex coupling can be used horizontally or vertically, without modification or special parts. Information in Bul. 4100. 57 \*The Falk Corporation

**Electrical Equipment.**.....Condulet is the one complete line for corrosive locations. Bul. 2699 contains full information on Condulets for corrosive locations. 64 \*Crouse-Hinds Co.

\* From advertisement, this issue

**NEW...**  
from *Manzel*

**FLOW-actuated alarm**



**LUBE-LINE ALERT** gives positive protection to valuable compressors, engines, machinery and other equipment using force feed lubrication. Small, compact precision-made FLOW alarm inserts into oil lines near each terminal point.

- Fits any make of lubricator
- Connects electrically to any signal—horn, buzzer, light, whistle, telephone, relay
- Signals LACK OF FLOW through line
- Flow capacities from 1/2 cc to 2 qts/min.
- Handles any viscosity oil or synthetic
- Pressures to 10,000 psi in standard models
- Explosion-proof units available

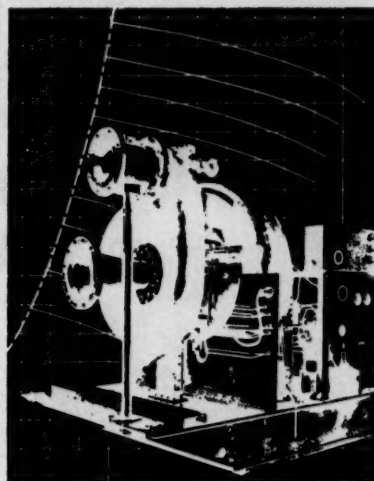
**FREE Specification Sheet** gives complete details.  
Write for your copy.

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**Manzel**  
HOUDAILLE INDUSTRIES INC.

Always **FIRST** with the **BEST** in lubrication

## TURBO COMPRESSORS with surge control at any speed or pressure



Turbo compressors whose operating range is extended by a unique surge controller\* are being produced by Stratos in sizes ranging from 200 to 20,000 cfm. Designed for operating pressures up to 3,000 psi, their high efficiency and internal aerodynamic cleanliness make them smaller, lighter and more compact than the usual run of such machinery. The surge controller is unique in that it senses surge *before* it occurs—incipient surge—and corrects to allow safe operation very close to the surge line.

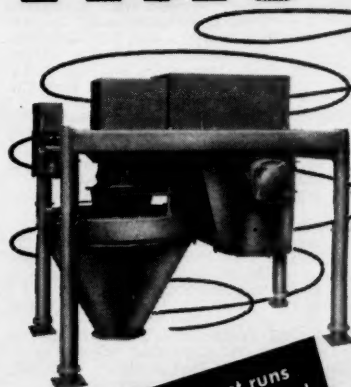
Reliability and safety are prime design considerations in Stratos turbo machinery. Each unit is thoroughly checked for both functioning and performance. Stratos' extensive test facilities enable it to conduct tests on air under simulated operating conditions. Units are delivered to the site as completely integrated packages, ready for connection. These packages can include lubrication systems, overspeed protection, oil pressure warning and other safety features.

Scaled design of Stratos turbine machinery precludes oil from infiltrating the gas stream. Zero leakage sealing can be provided for operation on toxic or explosive gases. Provision can be made for seal and bearing maintenance, including replacement, without removal from the line and without gas loss from the system. For information write to:

**STRATOS**  
INDUSTRIAL PRODUCTS BRANCH  
Bay Shore, L. I., New York  
A DIVISION OF FAIRCHILD ENGINE & AIRPLANE CORPORATION

\*Patents pending. Can also be applied to existing equipment.

## MIX BETTER BY IMPACT



Finer and more intimate dispersion of solids can be achieved using an Entoleter® centrifugal impact mill.

- Low cost — low power requirements
- Minimum (controlled) temperature rise

### RECENT APPLICATION

For the final dispersion of detergent, bleach, perfume and highly abrasive silica flour in a popular powdered household detergent, this 27" model with abrasion resistant impactors does the job.

Free test runs  
on your material.

Send for literature on Impact Milling, Particle Size Reduction and the new line of Vibrating Screens.



**ENTOLETER**  
DIVISION OF SAFETY INDUSTRIES

# DAY

Pneumatic Conveying & Bulk Storage News

**FREE!** 2 valuable guides  
for selecting  
**PNEUMATIC CONVEYING  
and BULK STORAGE TANKS**



**BULLETIN 574**—12 pages, describes horizontal and vertical storage tanks. Points out savings and is filled with photos of various installations plus description of auxiliary equipment.

**BULLETIN M-588-12** page DAY pneumatic conveying guide just off the press. Discusses types of systems, illustrates and diagrams high and low density arrangements, shows equipment and tells "why" and "wherefore" of all types of pneumatic conveying including so-called fluidizing systems.



Whatever your pneumatic conveying or bulk storage problem, look first in these DAY bulletins. They are valuable aids in selecting and ordering the right equipment for your plant. For your free copies use reader service card of this magazine or write direct to DAY.

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**EQUIPMENT ONLY OR A COMPLETE SYSTEM**

## LITERATURE . . .

**Mechanical Seal**.....Catalog 480, in up-dated form, adds more comprehensive information and illustration to older edition on line of mechanical sealing products.  
222A Durametallic Corp.

**Motors**.....C-W SEALEDPOWER motors now available up to 300 hp, in totally enclosed, fan-cooled & explosion proof designs. All the facts in new Bul. PB6000-2.  
105 \*Elliott Co.

**Switch**.....Series "CX" switch gives precise circuit control for long-life maintenance-free operation. Operating force—4 lbs. maximum. Data Sheet 156.  
58 \*Micro Switch

**Swivel Joint**.....Interchangeable packing feature enables DS Series to handle a wide range of chemicals in services from —65 F to +400 F at 300 PSI. Bul. No. 1258.  
27 \*Chiksan Company

**Turbines, Axial-Flow Impulse**..... built with one, two or three rows of high-grade stainless steel blading. Available in moderate & high steam pressure. Bul. S-143.  
48c \*The Terry Steam Turbine Co.

**Turbines, Multi-Stage**..... designed for non-condensing, condensing, mixed pressure or bleeder operation. Sizes up to 5000 HP, speeds up to 10,000 RPM. Bul. S-146.  
48a \*The Terry Steam Turbine Co.

**Turbines, Solid-Wheel**.....are available in vertical designs depending on frame size. Capacities from 5 to 2,000 HP. Described in Bulletin S-116.  
48b \*The Terry Steam Turbine Co.

## Handling & packaging

**Bulk Handling System**.....The Tote, mechanical, automatic system, is based on metal bins plus filling & discharging equipment. Catalog contains details.  
50 \*Tote System, Inc.

**Chain Drives, Conveyors, Elevators**.....Two new handbooks outline installation, operation and maintenance procedures for chain drives and chain conveyors and elevators.  
222B Chain Belt Co.

**Conveying Guide**.....A 12-page conveying guide discusses types of systems, illustrates & diagrams high & low density arrangements & shows equipment. Bul. M-588.  
222a \*The Day Company

**Conveyor**.....Airslide Fluidizing Conveyor fluidizes dry, pulverized materials with low pressure air. Take up little space, can be used singly & in combination.  
44 \*Fuller Co.

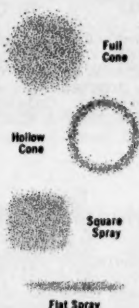
**Load Cell Scales**.....The advantages of load cell operation are available in . . . axle load scales . . . motor truck scales . . . crane scales . . . hopper scales etc. Bul. 2970.  
226 \*Toledo Scale Corp.

**Steel Tanks**.....Plate work and steel tanks for the petroleum industry is the topic of one new brochure. Another deals with the manufacturer's world-wide services.  
222C Chicago Bridge & Iron

\* From advertisement, this issue

## SPRAY NOZZLES

greater  
choice  
of  
patterns



greater  
choice  
of  
capacities

greater choice  
of materials  
and  
spray nozzle  
types



Over 12,000 Standard Spray Nozzles  
for more exact performance  
to fit your needs



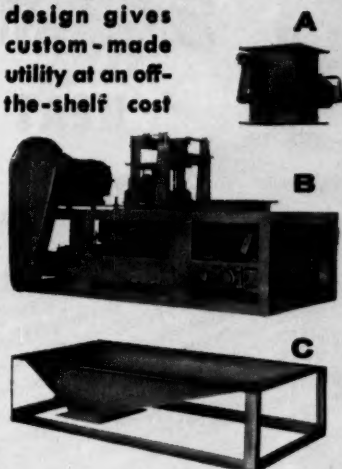
For complete information  
write for Catalog No. 24

**SPRAYING SYSTEMS CO.**  
3273 Randolph Street • Bellwood, Illinois



## UNITIZED WEIGHER-FEEDER

Building-block  
design gives  
custom-made  
utility at an off-  
the-shelf cost



UNITIZED construction makes the W-C Weigher-Feeder readily adaptable to practically any processing setup. Components are standardized, proven and interchangeable . . . pre-engineered with virtual "plug-in" simplicity.

**A** The UPPER FRAME controls material input, is supplied with a rotary feeder, sliding gate, vibratory feeder or other mechanism matched to material and flow requirements.

**B** The CONVEYOR FRAME, where material is weighed, includes a complete conveyor section, weighing pan and transmitter with integral tare adjustment. W-C's system of flexure mountings assures accurate measurement despite uneven loading or pile-ups. There are no knife-edges, beam pivots or other points of concentrated wear to affect accuracy.

**C** The LOWER FRAME is optional; can be a simple chute as shown.

In addition, the W-C Weigher-Feeder is designed to handle such instrument-controlled functions as flow totalizing, recording, programming, and material proportioning. Units are also available for installation on existing conveyors.

Complete information is given  
in Catalog 12. Write for a copy



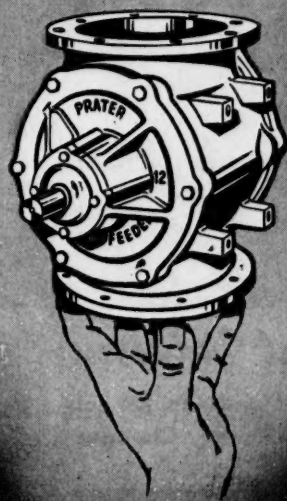
**WEIGHING and Control COMPONENTS, Inc.**

206-R Lincoln Ave., Heilbronn, Pa.

## PRATER — the recognized leader

### ROTARY AIRLOCK FEEDERS

for  
DUST CONTROL  
and  
PNEUMATIC  
CONVEYING



WRITE FOR BULLETIN P58

## PRATER PULVERIZER COMPANY

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**\*FIRST LINE**

*Extended Surface*

## HEAT EXCHANGERS

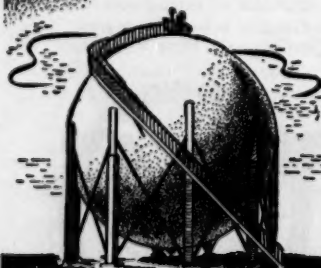


## ASK THE AEROFIN MAN

Specify Aerofin and you specify high efficiency, long service life and low maintenance and service costs.

Take advantage of Aerofin's unequalled experience, production facilities, and materials-testing and design research — of Aerofin's complete engineering service at the plant and in the field.

*\* Aerofin makes extended heat surface exclusively — not as a by-product, not as a side-line.*



*Throughout the  
Chemical Industry —*

**Aerofin units do the job  
Better, Faster, Cheaper**

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Syracuse 1, N. Y.

*Aerofin is sold only by manufacturers of  
fan-system apparatus. List on request.*

### LITERATURE . . .

**Storage Tanks.** . . . Bulletin 574 describes horizontal & vertical storage tanks. Filled with photos of various installations plus description of auxiliary equipment.  
222b \*The Day Company

**Tanks.** . . . for chemical storage. Also pressure vessels and processing equipment of aluminum & special alloys. Copy of "Tank Talks" on request.  
BL227 \*R. D. Cole Mfg. Co.

**Wegher-Feeder.** . . . is designed to handle such instrument-controlled functions as flow totalizing, recording, programming & material proportioning. Catalog 12.  
R223 \*Weighing & Control Components

### Heating & cooling

**Air Heaters.** . . . Type CA heater can be used in a wide variety of installations & with either gas, oil or combination firing. No refractory required. Bulletin #104.

213 \*Thermal Research & Engr. Corp.

**Condensers & Heat Exchanger Tube** . . . Complete information contained in Condenser & Heat Exchanger Tube Handbook which is now available on request.  
26 \*Bridgeport Brass Co.

**Far-Infrared Heating.** . . . Catalog illustrates and describes a complete line of far-infrared heaters and controls. Ratings range from 375 w. lengths from 12-3.4 in.  
224A Edwin L. Wiegand Co.

**Heat Exchanger.** . . . Aero Heat Exchanger is a self-contained fluid cooling system. It offers accurate temperature control. Bulletin No. 132 is available.  
TL219 \*Niagara Blower Company

**Heat Transfer Cements.** . . . Engineering Data Book 502 contains information on properties & uses. Includes estimating & installation data, illustrations, etc.  
224B Therman Mfg. Co.

**Preheater, Air.** . . . Factual information on Ljungstrom Air Preheater is contained in a reprint of a published magazine article which is available on request.  
42 \*The Air Preheater Corp.

**Rotary Coolers.** . . . in four types: Gas-Cooled, Water-Cooled Shell, Tubular, and Direct-Contact Water. Further information is available on request.  
234 \*Hardinge Co. Inc.

**Steam Jet Ejectors.** . . . available from 1 to 7 stages—a few inches of vacuum down to one micron of absolute pressure—evacuating small or large loads. Bul. No. 70A.  
81 \*Graham Mfg. Co., Inc.

**Steam Traps.** . . . Selector Chart in Strong Catalog No. 69A gives trap recommendations for 45 types of equipment. Steam Traps for every types of service.  
79 \*Strong, Carlisle & Hammond

**Thermo-Panel Coils.** . . . Take the place of old-fashioned pipe coils. Assure increased capacity. Complete facts & prices of the latest models are available.  
TL231 \*Dean Products, Inc.

\* From advertisement, this issue

# Wire Cloth-Filter Cloth

TO YOUR EXACT REQUIREMENTS

in Rolls or  
Cut Pieces



**WIRE CLOTH** all standard grades, for Industrial and Paper Mill use, all weaves, widths to 244", corrosion-resistant alloys.

**FILTER CLOTH** all standard weaves and densities, woven in corrosion resistant alloys, extra wide.

**NEVA-CLOG** perforated metal sheet filter medium—strong, rigid, smooth, non-clogging.

**MYKRO-PORE** electrodeposited metallic filtering or straining medium with retention to 20 microns.

**MICRO-MESH** high shute count filter cloth up to 1500 wires/in.—retention to 10 microns.

in Fabricated  
Components



"RIM-LOK" leaves for stationary leaf batch pressure filters, vertical or horizontal shell.

Filter leaves (bare or covered) for all other standard pressure filters.

Custom-made leaves and elements to your special design.

Screens—Strainers—Cylinders—Vibrating Screens

Discs—Process Equipment or components—Trays

Inquiries invited. Write for Catalog

**MULTI-METAL WIRE CLOTH CO., INC.**  
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## NOW! VIKING PUMPS

in a complete line of  
**ALLOYS**

Stainless Steel

Monel

Steel-Nickel

Nodular Iron

Ni-Resist

White Bronze

and many others

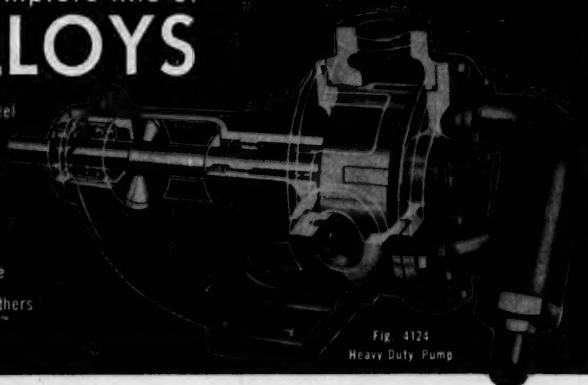


Fig. 4124  
Heavy Duty Pump

Have problems of handling liquids and semi-solids of a corrosive nature, or where contamination is not permitted? Viking Rotary Pumps made of alloys to fit the need, will answer those pumping problems.

Available in a capacity range from 1/4 to 300 G.P.M. and larger. New induction melting foundry facilities mean rigid control and faster delivery of the complete line of Viking alloy pumps.

Send your pumping problem to Viking today and ask for Alloy Pump catalog MC.

VIKING — The Leader  
not a follower  
in Rotary Pumps



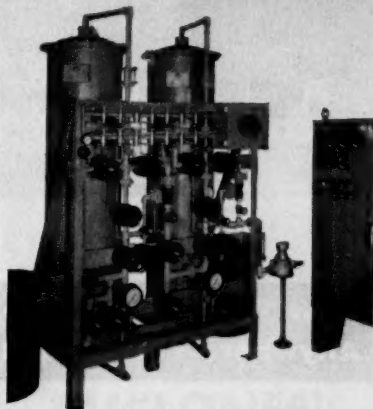
**VIKING PUMP COMPANY**

Cedar Falls, Iowa, U.S.A. In Canada, it's "ROTO-KING" pumps  
See Our Unit in Chemical Engineering Catalog

SET IT DOWN!  
HOOK IT UP!

**ILLCO-WAY**

**ionXchange**



## COMPLETE AUTOMATIC DE-IONIZER

Here is a complete, loaded, fully-instrumented, automatic ionXchange unit in a neat, compact, and ready-to-operate "package." It is equipped with our own Illco/Matic, all-plastic, air-actuated valves, which have been specially developed for ionXchange service. The Control Panel, also our own design and manufacture, provides all necessary quick-adjustment features, and requires only electrical hook-up to the terminal box on the frame. The only other connections required are to plant service.

### FULLY ASSEMBLED AND READY TO INSTALL

All structural assembly of elements, all piping, all wiring, and all installation of air lines is done in our factory by men of long experience. Then the unit is tested for proper operation of all circuits, loaded with the proper supporting beds and resins, painted, bolted to a skid, and crated for delivery to the exact spot it will be used. This is the quickest, easiest, and surest way for you to get a reliable, ready-to-go ionXchanger — arranged and instrumented to suit your special needs, whatever they are.

Write for Particulars



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NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.  
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Can.

# The Electronic Load Cell Brings New Versatility To TOLEDO SCALES



Now The Dial Can Be Located  
Anywhere You Want It!

The advantages of load cell operation are available in... axle load scales... motor truck scales... crane scales... hopper scales... tank scales... built-in scales... floor scales... custom test devices.

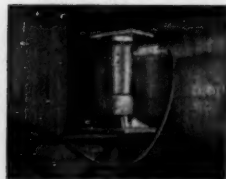
Add the flexibility of load cell operation to traditional Toledo accuracy and dependability... and you have a whole new concept of weighing ease and convenience.

Normally, the indicating element of a scale must be connected mechanically to the lever system. Not so, however, with load cell scales. You can locate the big 20" Toledo dial anywhere you want it, because only electrical connections are needed. And smooth, reliable Toledo servo action assures fast dial indicator response.

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These modern Toledos are available either as full Load Cell scales, or as Lectro-Lever scales. The latter combines a mechanical lever system with a load cell mounted in the nose iron or in the steelyard, and provides the benefits of remote indication where this combination is desired.

Toledo recording and indicating accessories are available with Toledo Load Cell Scales, including Toledo Printweigh "400" which prints full-figure weight data on tickets, strips or sheets.



All Toledo Electronic platform scales have the exclusive features and superior accuracy of a self-aligning post suspension system.

Ask your Toledo representative about new Toledo Load Cell Scales for your needs. Or, SEND FOR BULLETIN 2970. TOLEDO SCALE, Division of Toledo Scale Corporation, Toledo 12, Ohio.



**TOLEDO®**  
greatest name in weighing

## LITERATURE . . .

### Instruments & controls

**Computer System.**....The new TPR Data Scanner makes it possible to link a test or operational plant facility directly to any computer in the country.

**I** \*Daystrom Inc.

**Control, Liquid Level.**....is available for controlling level changes from 1/4" to 150 ft. Multi-stage switching when desired. More details on request.

**TL229** \*Magnetrol, Inc.

**Controllers.**....Type 2300-249 Electronic Level-Trol is ideal for use in hazardous locations. Type 2500-249 Level-Trol can be pneumatically operated.

**32-33** \*Fisher Governor Co.

**Data Processing System.**....Information on the 123 Data Processing System or an on-stream survey may be obtained by writing for Data File 14-37-09.

**93** \*Beckman Instruments Inc.

**Electronic Computer.**....for automatic computation with no limitation on the complexity of system. Offers full accuracy. Details available on request.

**187** \*Blaw-Knox Co.

**Gas Analyzer.**....An analyzer that detects contaminants in air or process streams in parts per billion is described in Bulletin 0714-3. Many detectable contaminants.

**226A** Mine Safety Appliances

**Gas Chromatography.**....71 p. workbook covers basic theory, instrument design, column technology and applications. Whole section on application to continuous process.

**226B** Beckman Instruments, Inc.

**Indicator, Self-Balancing.**....The new potentiometer & bridge type indicators give you full 34" scale readability at a distance. Catalog 65-E available.

**186** \*Thermo Electric Co., Inc.

**Instruments.**....Dynamaster Potentiometer & Bridge Instruments can be equipped with analog-to-digital encoders of various types for digital readout & computer use. Bul.

**52** \*The Bristol Co.

**Instrument.**....Radionic for positive on-off control & determination of liquid or solid level within a closed vessel or piping using nuclear radiation. Bul. 558.

**TL227a** \*Instruments, Inc.

**Instrument.**....Elect-o-probes are now in use for detection of liquors & foam in pulp & paper mills; heavy fluids, acids & fluid interface in chemical plants. Bul. B-06.

**TL227b** \*Instruments, Inc.

**Meters, Displacement.**....measure liquids accurately up to 100 gpm, insuring greater uniformity of product. Meters measure volumetrically. Complete information.

**215** \*Buffalo Meter Co.

**Nuclear Density Gage.**....Bulletin SG discusses method of operation and advantages of the Ohmart nuclear density gage for control of slurries, interfaces, etc.

**226C** Ohmart Corp.

\* From advertisement, this issue

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LEVEL INDICATION • DETECTION • CONTROL

### BY RADIATION ...



For positive on-off control and determination of liquid or solid level within a closed vessel or piping using nuclear radiation. Mounted externally. RADIONIC is used NOW for CO<sub>2</sub> fill control, uranium ore hoppers, food container filling, varnish blending, acid slurry refining, asphalt pots, 'green salt' reactors, high energy jet fuels, latex drums, electrical transformer case filling.

Write for Bulletin No. 558

### BY CAPACITANCE ...



MODEL B-06

A capacitance operated super-sensitive electronic relay. Detects liquid or solid levels, liquid-liquid or foam-liquid interface\*. Probe mounted internally. ELECTRO-PROBES® are NOW in use for detection of liquors and foam in pulp and paper mills; heavy fluids, acids and fluid interface in chemical plants; alarm for refrigerant control in freezing plants; mixed feeds; water-oil interface; fluids in dairies, breweries, etc.

Write for Bulletin No. B-06

\* Model B-06 shown features unitized explosion-proof construction, plug-in components, tank side mounting.



**INSTRUMENTS, INC.**

## TANKS for CHEMICAL STORAGE

Backed by  
103 Years of  
Fabrication  
Experience



• We have been supplying the chemical processing industry with tanks and vessels for chemical storage for three generations. In addition to carbon and stainless steel, we also fabricate and erect tanks, pressure vessels and processing equipment of aluminum and special alloys. . . . Investigate our facilities and take advantage of our 103 years of specialized knowledge and experience. . . . Write for *Tank Talks*.



Elevated Tanks, Pressure Vessels, Chemical and Processing Equipment from Aluminum, Stainless and Carbon Steel, Monel and Other Alloys.

Established 1854

**R. D. COLE MANUFACTURING CO.**  
NEWMAN, GEORGIA



HIGH EFFICIENCY

**DUCLONES®**

assure maximum recovery  
at lowest cost

DUCLONES—Ducon high efficiency cyclones—are designed and constructed for high recovery efficiency and low gas resistance. Their sturdy construction assures long, continuous service with a minimum of maintenance.

The exceptional performance of Duclon collectors is the result of these 6 unique features:

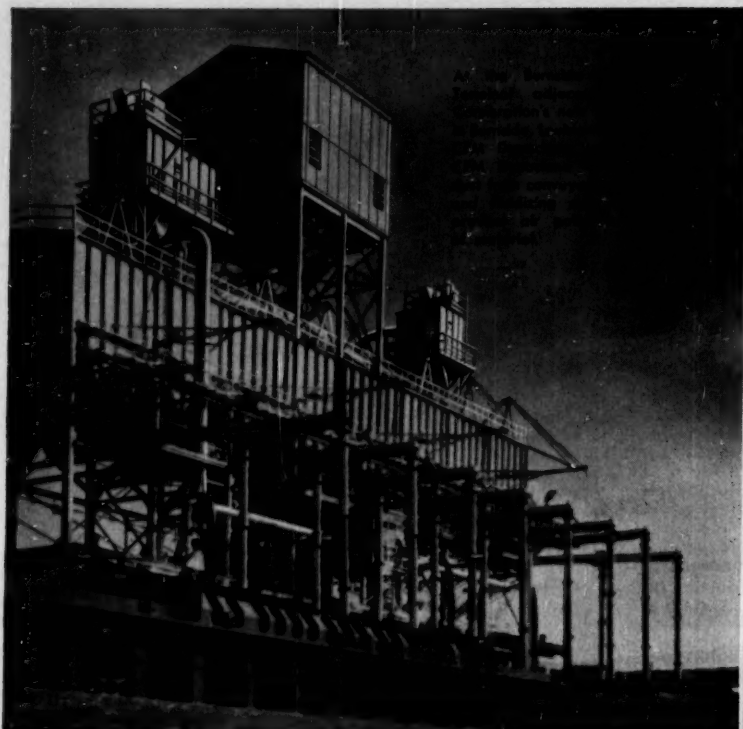
1. Small Diameter produces high efficiency
2. Helical Roof provides a turbulence-free path for the entering gas stream
3. Steep Cone improves dust separation
4. Dust Trap assures efficient dust removal from the cone
5. Vortex Shield prevents re-entrainment of dust in upward gas vortex
6. Scroll Outlet provides a low resistance clean gas outlet

send for Bulletin C-958.



the  
name in  
DUST  
Control

**THE Ducon COMPANY, INC.**  
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## Constant Suction! Complete Collection!

# SLY DYNACLONE®

## The Dust Filter for Continuous Processes

Just turn this dust filter on and forget it. The Dynaclone operates continuously, 24 hours a day. It maintains constant, uniform suction at dust sources, reclaims all the dust to prevent air pollution and damage to plant equipment.

The Dynaclone has new "Resist-O-Wear" filter bags (patent pending) that give as much as three times longer bag life . . .

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And it contains more cloth per cubic foot of filter than any other make . . . greater filtering capacity with smaller space requirements.

Learn the many reasons why the Dynaclone represents a new high in dust filter efficiency . . .

Send for 36-Page Catalog 104

SEE THE DYNACLONE in Space 73, the Chemical Show, New York Coliseum, Nov. 30-Dec. 4



### THE W. W. SLY MANUFACTURING CO.

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OFFICES IN PRINCIPAL CITIES

OVERSEAS LICENSEE: ANDREW AIR CONDITIONING LTD., LONDON S.W. 1, ENGLAND

#### LITERATURE . . .

**Pneumatic Transmitters**.....made in pressure & temp. types, each in regular & short span. Operation is on low-pressure air: output range, 3-15 psi or 3-27 psi. Bul. 361. 108 \*Manning, Maxwell & Moore, Inc.

**Pressure Gages**.....Pressure & vacuum elements—spiral, intermediate-range spring & bellows, low-range spring & bellows, dual spring & bellows for absolute pressure. Cat. 16-17f \*Minneapolis-Honeywell

**Specific Gravity Indicator**.....Instruments for the continuous measurement of specific gravity eliminate manual sampling. Thoroughly discussed in Bulletin 18S. 228A Schutte & Koerting

**Temperature Control**.....available in pneumatic, electric or self-contained gas types, in recording, indicating or non-indicating models. Full details offered. 112 \*The Parlow Corporation.

**Thermometers**.....Thermal systems—vapor, mercury, or gas actuated, case, case and capillary, or self-compensated. Complete information contained in Catalog C-60-2. 16-17a \*Minneapolis-Honeywell

#### Pipe, fitting, valves

**Expansion Joints**.....made in a wide variety of stainless & high temperature alloys in a complete range of sizes from 1/4 in. to 35 ft. in diameter. Pamphlet. 11

\*Solar Aircraft Co.

**Expansion Joints**.....are hydraulically formed. Welding techniques insure welds having the same thickness, strength & physical properties. Catalog 56. 89

\*Zallee Brothers

**Fittings**.....Speedline fittings feature flange without welding, leakproof union joints and easier, faster alignment. The Speedline Catalog is offered. 99

\*Horace T. Potts Co.

**Flexible Connectors**.....Dampen vibration, compensate for misalignment, permit offset movement, absorb expansion & handle most flexing applications. BL219

\*Allied Metal Hose Co.

**Glassed Ductile Iron Fittings**.....New bulletin contains charts, fitting specifications and general descriptive data on a line of glassed ductile iron fittings. 228B

Pfautler Co.

**Hose**.....for every application in the chemical industry, there's an R/M hose or Condor Flexible Rubber Pipe. Bulletins on different types are available. 40

\*Raybestos-Manhattan, Inc.

**Pipe & Fittings**.....New technical brochure covers PVC rigid plastic pipe & fittings. Ideal for more efficient, economical & corrosion-free systems. 230

\*Mueller Brass Co.

**Pipe, Plastic**.....New 36-pg. Technical Handbook on PVC pipe is filled with information including flow charts & a corrosion resistance chart covering more than 160 acids. 121

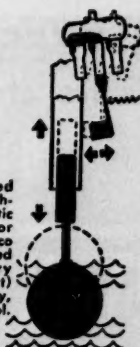
\*Kraloy Plastic Pipe Co., Inc.

\* From advertisement, this issue

**permanent  
magnetic  
force...**



A sleeve, raised and lowered within a nonmagnetic tube, attracts or releases an Alnico magnet attached to the mercury (or dry contact) switch. Basically, this is Magnetrol.



**The operating principle  
behind *MAGNETROL*  
LIQUID LEVEL CONTROL**

Because its operating principle, based on the proper use of a permanent magnet, guarantees a perpetual guardianship over your critical liquid levels, the Magnetrol liquid level control unobtrusively takes the most important place in any system or process where it is necessary to keep a liquid at a constant level. Principle and action are so simple that failure is virtually impossible. Magnetrol is versatile, too—will handle almost ANY liquid, at ANY temperature, at ANY pressure, with the same precision and dependability. No mechanical or electrical linkages to stick, bind, ride out of line or wear out. Available for controlling level changes from  $\frac{1}{8}$ " to 150 ft. Multi-stage switching when desired. Write to

**MAGNETROL, Inc., 2124 S. Marshall Blvd., Chicago 23, Illinois**



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**FOR LIQUIDS AND GASES**

**SPHERES • DIALIFT SYSTEM**

**DIAFLOTE TANK • VAPOR-LIFT SYSTEM**

**FLOATING ROOF • PLASTIC COVER**

STEEL PLATE • STAINLESS STEEL • STAINLESS CLAD PLATES • T-1 STEEL  
AND OTHER STEEL ALLOYS • NICKEL-CLAD • ALUMINUM • ETC.

**FIELD ERECTED TANKS AND VESSELS FOR LIQUIDS,  
GASSES, VAPORS AND STORAGE OF DRY MATERIALS**

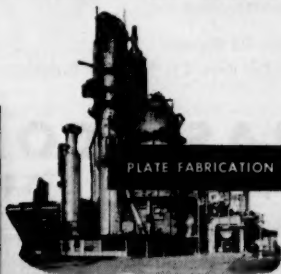
ELEVATED TANKS

**HAMMOND IRON WORKS**

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Chicago and Plants

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**RUBBER TREADS . . .** a wide choice of treads suited to all types of floors, including Darnelloprene oil, water and chemical-resistant treads, make Darnell Casters and Wheels highly adapted to rough usage.

**RUST-PROOFED . . .** by zinc plating, Darnell Casters give longer, care-free life wherever water, steam and corroding chemicals are freely used.

**LUBRICATION . . .** all swivel and wheel bearings are factory packed with a high quality grease that "stands up" under attack by heat and water. Zerk fittings are provided for quick grease-gun lubrication.

**STRING GUARDS . . .** Even though string and ravelings may wind around the hub, these string guards insure easy rolling at all times.

## NEW MANUAL

This FREE DARNELL MANUAL should be in your files — it describes over 4000 types of casters and wheels and will quickly help you solve every caster and wheel problem

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# THE CORROSION-FREE WAY to handle chemicals



MUELLER BRASS CO.

**PVC**

(POLYVINYL CHLORIDE)

RIGID PLASTIC PIPE AND FITTINGS

The answer to most chemical corrosion problems can be found in an installation of Mueller Brass Co. PVC rigid plastic pipe and fittings. PVC pipe has proven itself invaluable to the chemical industry because of its high resistance to corrosion. Water, oil, gases, alkaline or salt solutions, alcohol and a wide variety of acids have no deteriorating effects upon PVC. Its extremely smooth interior bore eliminates pipe clogging and fouling and assures continuous maximum flow capacity. PVC is exceptionally strong, retaining its dimensional stability under stress, impact and moderately high temperatures. Mueller Brass PVC's life long built-in finish reduces maintenance costs and completely eliminates the need for painting or other protective coating. It is light and can be easily joined by threading or solvent cement, thus saving on installation time and expense.

For more efficient, economical and corrosion-free systems, specify Mueller Brass Co. PVC plastic pipe and fittings.

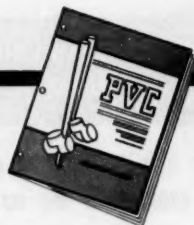


NORMAL IMPACT PVC—good impact strength . . . maximum chemical resistance.

HIGH IMPACT PVC — maximum impact strength . . . high chemical resistance.

Pipe is fabricated in 20' lengths; 1/2" through 3" sizes—I.P.S. schedules 40 and 80. Fittings are available in 1/2" through 3" sizes; threaded and socket-type for schedule 80 and in socket-type only for schedule 40.

Write for the new  
Mueller Brass Co. Technical Brochure.



**MUELLER BRASS CO.**  
PORT HURON 51, MICHIGAN

274-A

POLYETHYLENE PIPE AND PLASTIC FITTINGS, COPPER TUBE, VALVES AND FITTINGS

## LITERATURE . . .

**Pressure Plugs.** . . . Pressure plugs that seat flush are discussed in a new bulletin. Tables and charts give complete specifications for a range of sizes from 1/16 to 1 1/4 in.  
230A Standard Pressed Steel

**Pulp and Paper Valves.** . . . Bulletin shows the application of valves and other control equipment in modern pulp and paper processes. Glossary of industry terms.  
230B Conoflow Corp.

**Stainless Tubing.** . . . Data card describes the high-temperature properties of Croloy 25-12 (309), its chemical composition. Tubing, pipe and welding fittings  
230C Babcock and Wilcox

**Steam Specialties.** . . . Steam specialties—valves, thermostatic traps, float and thermostatic traps and line strainers—are discussed in composite Bulletin 203.  
230D American Air Filter

**Tubes.** . . . A complete range of stainless grades to meet any set of service conditions. Fully annealed tubes for maximum resistance to corrosion. Bulletin TB-329.  
120 \*The Babcock & Wilcox Co.

**Valve, Ball.** . . . in pipe sizes 1/4" to 8" in Bronze, Aluminum, Stainless Steel, Carbon Steel & PVC Quarter Turn. Literature on "Ball Valve" Principle.  
199 \*Jamesbury Corp.

**Valve, Union Check.** . . . allows free passage of product separating or line cleaning devices. Fits 2" diameter Pipe. Rated 500 P.S.I.—W.O.G.  
122 \*Clayton Mark & Company

**Valves.** . . . "Craneloy 20" valves for acid service. Circular AD-2080 will bring you up to date on corrosion-resistant alloy valves. No leakage, galling or seizing.  
107 \*Crane Company

**Valves.** . . . Type F valves are available from 1/4" thru 4" in nine standard corrosion resisting alloys. Complete details in Bulletin V/4b. Send for your copy.  
177 \*The Durlon Company, Inc.

**Valves.** . . . Nine new flanged end forged steel Gate, Globe & Check valves are available. Literature on sizes, pressures and types of the complete line is offered.  
124 \*Henry Vogt Machine Co.

**Valves, Control.** . . . New 20-pg publication lists valve bodies & actuators and the accessory line available for control valves. Valve sizing data included in Bul. 150.  
230E DeZurik Corporation

**Valves, Pinch.** . . . for corrosive & abrasive pulps & liquids. Pressures to 150 psi, temperatures to 200 F. Catalog gives complete data & list of recommended applications.  
216 \*The Mine & Smelter Supply Co.

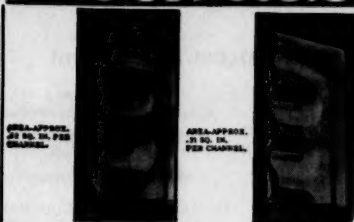
**Valves, Plug.** . . . A complete line of lubricated plug valves with sizes from 1/4" to 36" & pressures to 15,000 lb. Complete details are available.  
103-104 \*Rockwell Mfg. Co.

**Valves, Safety Relief.** . . . Consolidated safety relief valves with sealing bellows, type 1900-30 series, in sizes 1 1/2" x 2" to 8" x 10". Details on all types in Cat. 1900.

46 \*Manning, Maxwell & Moore, Inc.

\* From advertisement, this issue

## A SIMPLE WAY TO CUT COSTS



Above we show how the



**DEAN®  
THERMO-PANEL  
COIL**

is made. It TAKES THE PLACE of old-fashioned pipe coils. Usually costs much less. Weighs less. Uses less space. More efficient. More economical. Better in every way.

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ASK FOR  
COMPLETE DATA  
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on the latest Dean models which assure INCREASED CAPACITY. Write, phone, or wire.

Backed by 24 Years of Panel Coil Manufacturing

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### TORQUE RANGES (to 800 Foot pounds)



both from one

## Sturtevant TORQUE WRENCH

Now you can do high torque work with a Sturtevant Torque Wrench of normal capacity range—small in size—light in weight—with fine increment markings and moderately priced.

With a new Multi-range, Multi-purpose Adapter you can step up the capacity of your Torque Wrench to a new high range and you can plug in any drive end you want... Box wrench, ratchet, drive square for sockets.

All drive end accessories are interchangeable and stock items.

In this way each Sturtevant Torque Wrench effectively equals two complete sets of ordinary single purpose Torque tools.

Adapter Slide rule sent FREE if requested on company letterhead.

WIDE CHOICE OF  
INTERCHANGEABLE  
DRIVERS

PA **Sturtevant CO.**  
ADDISON QUALITY ILLINOIS

# PUMPS

## to handle LIQUID OXYGEN and other LIQUEFIED GASES

Lawrence Pumps Inc. has developed a special line of pumps for handling liquid oxygen, liquid nitrogen and other gases which can be liquified only at very low temperatures.

Because of the abnormal behavior of materials and liquids at extreme low temperature several of the following features are incorporated in these pumps:

1. Vertical top suction construction to prevent gas binding when the NPSH drops below the safe level, due either to drop in suction pressure, or rise in temperature of the liquid.
2. The packing box does not come in contact with the liquid, only with the blanket of gas in the pipe column.
3. The packing box is fitted with a mechanical seal which has been developed especially for this exacting service.
4. The design has been carefully developed and the materials selected to eliminate any troubles due to differences in expansion and to prevent galling between running parts.



Write for  
bulletin 203-7

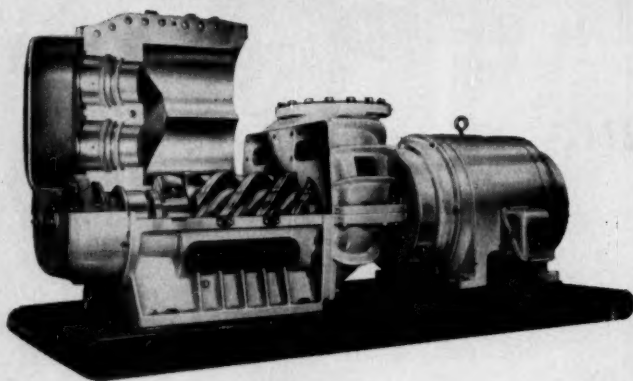


## LAWRENCE PUMPS INC.

371 Market Street, Lawrence, Mass.

You'll find this is

# the only rotary compressor with all these features!



Fairbanks-Morse Positive Displacement Axial-Flow Rotary Compressors are available in standard models in single-stage units, with capacities from 800 to 12,500 cfm. at compression ratios from 1.6:1 to 5.0:1—or in two-stage units with capacities from 2,000 to 12,500 cfm. at compression ratios above 5.0:1—and for booster service at maximum working pressures up to 250 psig.

- **High efficiency and stability** that rivals reciprocating machines.
- **Low weight and small space** requirement that cuts costs for installation, foundation and building.
- **Oil-free output**—no metal-to-metal contact of impellers or casing, no lubrication of parts contacting gas, air or vapor.
- **Mechanical simplicity**—no valves, no pistons or reciprocating parts to wear or replace.
- **Adaptability to any power source** permits choice of induction or synchronous motor, diesel engine, gas or steam turbine as prime mover.
- **Smooth, steady operation**—impeller speed and design produce even delivery of flow with minimum pulsation or vibration.

For complete information contact your nearby Fairbanks-Morse Branch, or write Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Ill. Ask for new Bulletin ACO 100.2.



## FAIRBANKS-MORSE

a name worth remembering when you want the BEST

COMPRESSORS • PUMPS • SCALES • DIESEL, DUAL FUEL AND GAS ENGINES  
LOCOMOTIVES • ELECTRIC MOTORS • GENERATORS • MAGNETOS • HOME WATER SYSTEMS

## LITERATURE . . .

### Process equipment

**Airlock Feeders.** . . . Bulletin P58 "How to Select A Rotary Airlock Feeder" is now available on request. Airlocks solve many processing problems.

BL223 \*Prater Pulverizer Co.

**Automatic De-Ionizer.** . . . Complete, loaded, fully-instrumented, automatic ionXchange unit. Full particulars on this equipment is now available.

R225 \*Illinois Water Treatment Co.

**Blended.** . . . New centrifugal Liquid-Solids blenders sizes range from laboratory models to 50 cu. ft. capacity. Information on blenders & Vacuum Tumble Dryers offered.

66-67 \*Patterson-Kelley

**Centrifugal.** . . . Illustrated details on Tolhurst centrifugals time & space-saving advantages is now available. Also data on the Batch-O-Matic centrifugal.

211 \*American Machine & Metals, Inc.

**Classifier.** . . . Super-D-Canter is applicable to wide range of both amorphous & crystalline solids. Models available for operation at pressures to 150 psi. Bul. 1254.

37c \*The Sharples Corp.

**Colloid Mill.** . . . Model 2A is available for processing quantities as small as 8 ounces, & is invaluable for research, laboratory or pilot plant applications.

30b \*Manton Gaulin Mfg. Co.

**Continuous Dehydrator.** . . . is especially applicable for high concentrations of medium-to-coarse crystalline solids & fibrous pulps. Available in four sizes. Data Sheet.

37a \*The Sharples Corp.

**Cyclones.** . . . Shave-off design permits large diameter cyclones that will not clog, plug, or bridge when properly operated. Copy of 12-page booklet is offered.

194 \*Buell Engineering Co., Inc.

**Demineralizer.** . . . Bantam Demineralizers does 5 water purification jobs & employs 5 interchangeable cartridges. Water Still Cat. G & Water Demineralizers Cat. 127-A.

252 \*Barnstead Still & Sterilizer

**Demineralizers.** . . . are available in mono-column, dual-column & multicolumn types. In flow rates from 10 to 10,000 GPH. Fifty standard models. Catalog.

R240 \*Penfield Mfg. Co., Inc.

**Dryers.** . . . Denver Dryers for the Chemical Process Industries are described in Bulletin No. D4-B4. Sizes to 8' x 60' and larger are available.

248e \*Denver Equipment Co.

**Dust Control.** . . . Duclones offer 6 unique features and are designed and constructed for high recovery efficiency and low gas resistance. Details in Bul. C-958.



R227 \*The Ducon Co., Inc.

**Ejectors.** . . . Available literature on single-stage, multistage & corrosion-resisting types illustrates design & construction for chem. & indus. process applications.

R201 \*Elliott Co.

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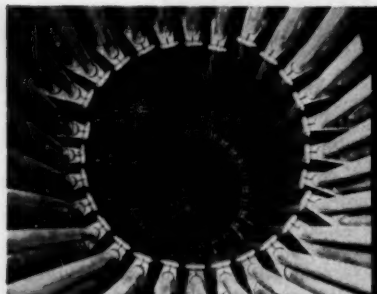
**GAS-COOLED TYPE**—Solids are cooled by direct contact with cooling air (atmospheric, or dried and refrigerated). Inert gases may be used in a closed system.

**WATER-COOLED SHELL**—Water is externally applied to the shell, either by sprays or by partially submerging the shell.

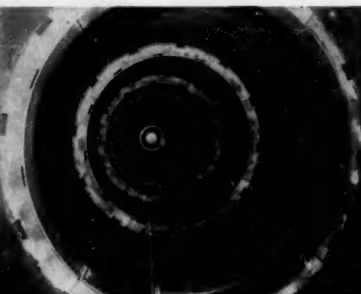
**TUBULAR TYPE**—Internal water-cooling tubes are assembled with the rotating shell, or installed as a stationary bank of tubes concentric with the shell. Alternately, the water leaving either of these tube sections may be used for supplemental spray cooling on the shell exterior.

**DIRECT-CONTACT WATER**—For rapid cooling from very high temperatures, water is sprayed directly on the hot material to utilize the latent heat of vaporization. Usually supplemented by secondary air cooling.

Each of these types has a particular area in which it is most economically applied. Write for further information.



Interior of a water-tube cooler. Longitudinal banks of tubes provide maximum cooling surface for minimum floor space.



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38 \*Blaw-Knox Co.

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8 \*Commercial Filters Corp.

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R217 \*Ertel Engineering Corp.

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**Filters, Disc**.....Agitator-type gives high filter capacity, lower moisture content & more uniform, dryer filter cake. Sizes to 9' dia. x 12 Disc. Bul. No. F9-B5.  
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TL221 \*Manzel

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12 \*Chemical Construction Corp.

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171 \*Schutte & Koerting Co.

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238A Stearns Magnetic Products

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248f \*Denver Equipment Co.

**Mist Eliminators**.....Latest design guides in the recommended type & method of installation best suited to your particular operating conditions are available. Bul. ME-9.

188 \*Metal Textile Corporation

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78 198 \*Abbe Engineering Co.

**Mixers**.....You'll find a wealth of information on fluid mixing in bulletins describing Lightning Mixers. Condensed catalog shows all types. No. B-109.

254a \*Mixing Equipment Co., Inc.

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165 \*Netco Corp.

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53 \*Swenson Evaporator Co.

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189 \*The J. H. Day Co.

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54 \*F. J. Stokes Corp.

**Samplers, Automatic**.....Wet, dry, dust tight units, multi-stage sampling, continuous or intermittent operation & complete sampling systems available. Bulletin No. SI-B4.

248g \*Denver Equipment Co.

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**Spray Dryers**.....Bulletin 442 covers spray dryers—their advantages, operation and application. A question and answer section is included. List of materials.

238B Proctor & Schwartz

## how to give yourself the air



Some raw materials are dirt-cheap—or even air-cheap. It's a steal when you can pump in a raft of outside air and ship nitric oxide or nitric acid out the back door. Maybe you want something less lethal from your oxidation-reduction process but whatever it is, activated charcoal when used as a catalyst does the job over and over again—and at low cost, too.

## how to find a silver lining



It's clouds of money back in the till when solvent vapors go back in the process. Solvent vapors can play hob with the process—and the people. One activated charcoal solvent recovery system took the contaminant out of the air, the complaint out of the employee, and put 2000 gallons of solvent back into the process daily. Are you prepared for recovery?

## activated charcoal

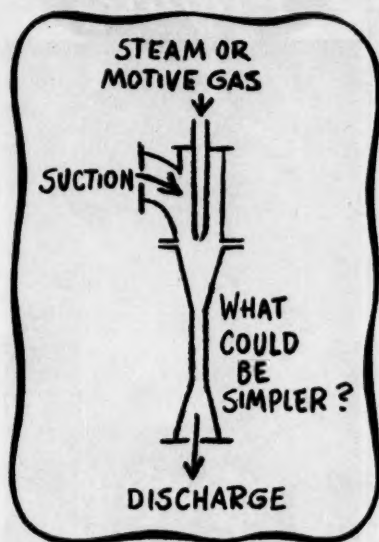


Activated charcoal (or carbon), a hard, granular, black material, acts as a molecular sponge, purifies air, gases, liquids—recovers solvents—removes odors and impurities—does hundreds of jobs. Write for Bulletin J-102. Barnebey-Cheney, Columbus 19, Ohio.

## Barnebey Cheney

\* From advertisement, this issue

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**In I-R Ejectors,  
nothing moves  
but the motive  
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## LITERATURE . . .

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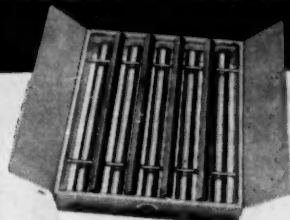
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R231 \*Lawrence Pumps Inc.

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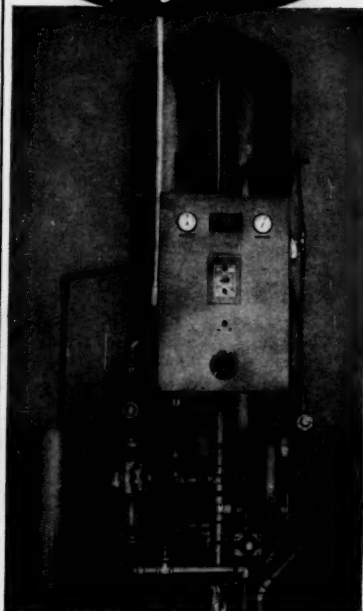
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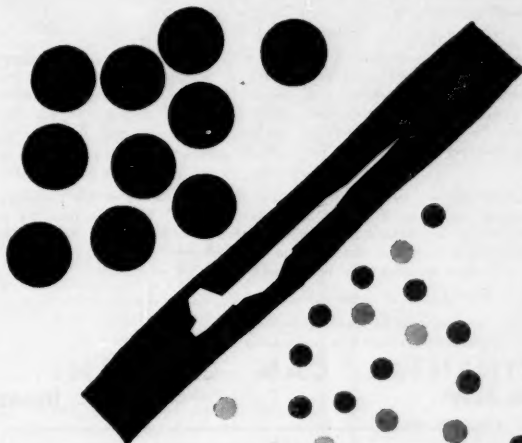
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- 1—AMERICAN Type D Dust Collector, Size 24 Rotoclean, hopper unit & skimmer, 40 HP motor
- 1—G. E. Drycycle Producer Unit, 200 CF per hour, Selas gas combustion controller, Type B, 650 CF per hr.
- 1—COLENDRIA Pan Unit, 11" w/condenser, vacuum, and recirculating pumps
- 4—HAMMER MILLS; WILLIAMS & WHITE, 30 HP; McKIN Pulverizer, 12" x 12" intake; 3050A Type UBS PREMIER MILL; DIXIE, 40" x 24" MILL
- 2—BAKER PERKINS Mullers, complete w/drives, 100HP
- 2—BYRON JACKSON Hydro Press Pumps, 213 GPM, 1800# press; direct connection to 250 HP motors
- 4—HONAN & CRANE Oil Purifiers, continuous Type, Model 1224-A (2) NEW, Mod. 1012AH & 1218A—Used
- 1—DeLaval Oil Purifier, Model 30-15 max. cap. 75 G.P.H.
- 3—ROSS Shell & Tube Condensers, Sizes 800-15, 1200-15, 1600-15
- 1—INTERNATIONAL Enamel Ball Mill, 70" dia x 85" long, 3600# cap; 3" McDaniel porcelain lining

### TANKS

- 300 gal. Stainless Steel mixing tank, with baffles and hopper, 42" dia. x 62"
- Heavy Duty Tank Car Tank, 8000 gal; w/heating coils, A-1 condition
- 8000 gallon vertical storage, like new
- 7000 gallon horizontal storage
- 7500 gallon vertical oil storage (2)
- 4000 gallon horizontal storage
- 70,000# Grade F, hydraulic accumulator, 26" dia x 21", #6F3726

### AIR RECEIVERS

- 60 gallon, 250#—NEW (6)
- Heavy duty 175# pressure capacity, 5' dia. x 22"

WE STOCK: Electric Motors & Controls to 750 HP, overhead cranes, blowers, beliers, mill exhausters, fans, hydraulic pumps, steam pumps, units & controls and speed reducers plus other miscellaneous items. WRITE . . . WIRE . . . PHONE—WE MAY HAVE IT!!

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- Filters: Vallex 49 S. S. covered leaves. #2 Sweetland 12 Stainless Leaves. Filter Presses: 6" to 36" Iron & Wood. Kettles: S.S. Jack. 20 to 500 gals.
- Dopp 350 gal. cast iron Jack. Vacuum. Devine Impreg. Units 30" & 36" dia. Steel, Alum. & Copper 5 to 2,000 gals.
- Mills: Raymond #00, 30 HP. & #0000. Mikro Pulverizers #4, 2, 1, & Bantam. Hammer Mills & Pulverizers 3 to 50 HP.
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- Mixers: Baker Perkins Jack. 100 gals. Day Imperial 75 & 150 gals. Change Can Mixers 8, 15, 40 gals. Day Jumbo 700 gal. horiz. mixer. Turbur. 1 ton Drum Blender 10 HP. Elystone 3000# horiz. spiral mixer. Day 1000# Spiral Mixers, & up to 3000#. Lancaster 6" dia. 25 HP. & up, 3 HP. Pumps: Stokes etc. Vac. 10 to 500 CFM. Gould 75 HP. Centrifugal 250 PSI. Sifters: Day, Robinson etc.
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- Hydr. Presses. Plastic & Rubber Machy.

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### STEIN EQUIPT. CO.

107-8th St., Brooklyn 15, N. Y.  
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- MILLS—Hammer—00 Sturtevant 10 HP, AKB Wms. 25 HP, 3W Mikro 30 HP, #2 Gruender Supramacher 40 HP, #50 Raymond 5/5 Imp, AKBX Wms. 50 HP, 30 NF Wms. 100 HP, 36 x 52 Jeffrey 125 HP, 5XT 14 Penna. 350 HP
- MILLS—Colloid—1 1/2" US 7 1/2 HP, 2" BAS 20 HP, PA Robinson 5 HP, Sprout Waldron 2-40 HP motors
- MILLS—Harding—Conical—4 1/2 x 16 (10 HP) pebble, 4 1/2 x 24 (25 HP) ball, 6" x 36" (60 HP) ball, 7" x 22" (75 HP) pebble, 8" x 36" (125 HP) ball, 8" x 48" (175 HP) ball, 10" x 48" (350 HP) ball
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- CONVEYORS—18" x 16" Farquar troughing, 18" x 34" spurs, 18" x 37" trough, Bucket elevators to your spec.
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- AUTOCLAVES—35 Gal. 5/5 Jacketed, 150 Gal. steel jacketed/agitated
- DRYERS—12" x 24" x 90" truck/tray, Steam—24" x 22", 33" x 18", 36" x 24", 44" x 25", 4" x 40", 5" x 40", 9" x 30" Rotary

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- 465 CFM 100 PSI 12x11-IR-ES-1-Worth HB
- 496 CFM Vac. 14x7 CPT (3)
- 502 CFM 125 PSI 12x13 Worth HB, IR-ES
- 686 CFM 100 PSI 14x13 ing. ES
- 823 CFM Vac. 18x7 ing. ES-1
- 917 CFM 100 PSI 15 1/2x8 1/2 ing. XLE 125 HP Syn. 3-60-2300
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- 1—175 cu. ft. dbl spiral ribbon blender, 30 hp, g.h. mtr.
- 1—82 cu. ft. blender, dbl spiral ribbon CD, 20 HP g.h. mtr.
- 1—Baker Perkins 200 gal. w/ cired dbl Sigma blades, jacketed, also internal pressure, Unidrol type, size 17, D.A.M. very heavy duty
- 3—Baker Perkins, size 17 200 gal w mixers, 30 hp mtrs., power screw tilt.
- 1—Baker Perkins 7 gal w, 30 hp mtr mixer, power screw tilt.
- 2—J. H. Day Series 80, 40" x 120" Roball Gyrating Screens w/mtrs.
- 1—Stokes model R tablet press.

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## MACHINECRAFT

- B. S. Reactor 1200 gal 200 lb pressure
- Baker Perkins 150 gal 40 HP, 100 gal 50 HP both S.S. 2 arm jacketed vacuum hydr. tilt
- Blaw-Knox 2 gal S.S. Autoclave 5000 lbs.
- 50 gal S.S. Autoclave 2000 lb pressure
- Vulcanizer 60" x 9' 125 lbs.
- Sweetland #2 all stainless
- Stainless steel Ball Mill
- Aluminum Condenser 350 sq. feet
- Aluminum Evaporator Calandria type, never used, 1380 sq. ft. tube area.
- Pfeiffer & Schwaartz Rinned drum driers
- Continuous Stripping column 2 X 13 Steel
- S.S. Centrifugals 40" bottom discharge, piew
- Calenders 3 Roll 45" X 18"; 6 Roll 12" X 5"
- Hydraulic Pumps, Motors.

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- Rotex 40"x84" sifter, #42 dbl. sep. 1 H.P. mtr.
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- Gruendler "BB" Hammermill, Whitebaker
- Pfaudler 1500 gal. Glass Closed Top Tank
- Patterson 6'x5' Jktd. Ball Mill, ex. pt. mtr.
- Gen. American 42"x120" Twin Drum Dryer
- Nash Hydr. Vac. Pump #6, with 40 H.P. motor
- Ribbon Blenders steel & SS, all sizes, new & used

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We are pleased to announce that we have just purchased a two acre site at 35-65 Jabez Street, Newark, N. J. (near Newark Airport). We expect to have our new office, shop and warehouse buildings ready for occupancy on or about October 30th. In order to save extra cost of handling, we are now ready to cut prices on every item we have in stock at our New York warehouses. THIS IS YOUR OPPORTUNITY TO TAKE ADVANTAGE of CONSIDERABLE SAVINGS ON YOUR PRESENT AND FUTURE REQUIREMENTS.

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#### CENTRIFUGALS AND CENTRIFUGES

- 3—Bird 18" x 28", continuous, Stainless & Steel Bowls.
- 1—Bird 36" x 50", continuous, Steel Bowl.
- 10—Sharples #26 & #16 Super Centrifuges, Stainless & Steel Bowls.
- 1—DeLaval #600 Separator.
- 1—Sharples Nozzlejector, 15 HP.
- 1—12" Stainless Basket.
- 1—Tolhurst 26" Steel Basket.
- 1—Fletcher 30" Steel Basket.
- 1—Tolhurst 32" Steel Basket.
- 1—AT&M 36" Rubber Basket.
- 1—Hepworth 40" Steel Basket.
- 2—Tolhurst 40" Steel Baskets.
- 1—Tolhurst 40" Bronze Basket.
- 1—Bird 40" Rubber Covered Basket.
- 1—Fletcher 40" Stainless Basket.
- 1—Bird 40" Stainless Basket.
- 1—AT&M 48" Stainless Basket only.
- 2—International Model FS-3, Bronze Baskets.

#### CRYSTALLIZERS

- 3—Swenson Walker 30" continuous, Steel.

#### ATMOSPHERIC ROTARY DRYERS

- 1—30" x 12' Aluminum Shell.
- 1—Vulcan 4' x 30'.
- 1—Link Belt 6'4" x 24'.
- 2—Vulcan 7' x 80'.
- 3—Louisville 8' x 50', Stainless Shells.

#### VACUUM DRYERS

- 1—Stokes 30" x 8' Rotary.
- 1—Devine 10 shelf, 40" x 43".
- 3—Buffalo 20 shelf, 60" x 80".
- 1—Devine 3 shelf, 14" x 14".

#### ATMOSPHERIC DRUM DRYERS OR FLAKERS

- 2—Devine 48" x 108", Single Drum.
- 2—Bufflovak 42" x 120", Double Drum.
- 1—Bufflovak 48" x 28", Bronze, Single Drum.
- 1—Bufflovak 24" x 36", Single Drum.

#### DRYING OVENS AND FURNACES

- 1—American Sterilizer, 3' x 2' x 3', electric.
- 1—Precision Sterilizer, 18" x 18" x 18", electric.

#### DIALYZERS

- 2—Brosite Machine Co., Steel and Stainless Leaves.

#### EVAPORATORS

- 1—Harris 3' dia. x 8 1/2' high, Stainless.
- 1—Condenser Service 5' dia. x 6' high, Stainless, 120 sq. ft.
- 1—Bufflovak Stainless, 250 sq. ft.

#### FILTER PRESSES

- 2—Shriver 12" x 12", Cast Iron.
- 4—Shriver & Sperry 18" x 18", Cast Iron.
- 4—Sperry 24" x 24", Cast Iron.
- 2—Sperry & Shriver, 30" x 30", Cast Iron.
- 1—Shriver 36" x 36" Cast Iron.
- 3—Skeletons, 18" x 18", 24" x 24", 32" x 32", 36" x 36".
- 1—Sperry 24" x 24", Aluminum.

#### SWEETLAND FILTERS

- 2—#27 Sweetland Filters.
- 2—#10 Sweetland Filters.
- 3—#12 Sweetland Filters.

#### ROTARY FILTERS

- 1—Oliver 53" x 8", 130 sq. ft.
- 1—Conkey 3' dia., 27 sq. ft.
- 1—Oliver Precoco 53" x 3', Rubber covered.

#### PRESSURE FILTERS

- 1—Sparkler 33-5-28, 151 sq. ft. Stainless.
- 3—Niagara 36H-110-3, 1110 sq. ft., Stainless.

#### FILLING MACHINES

- 1—Stokes & Smith G-1.
- 1—National Model H Type M.

#### 2—Rodgers Model 104.

- 1—Standard Knapp Case Packer.
- 1—Rodgers 8A Paste Filler.

#### INERT GAS GENERATOR

- 1—Kemp Size 3 MITHE, 3000 cfm.

#### CONDENSERS—HEAT EXCHANGERS

- 9—Struthers Wells, 20 sq. ft., Stainless.
- 2—Western, 28 sq. ft., Stainless.
- 2—Devine, 40 sq. ft., Copper tubes.
- 3—Devine, 60 sq. ft., Copper tubes.
- 4—Killebrew & Struthers Wells, 65 sq. ft., Stainless.
- 1—Whitlock, 90 sq. ft., Steel.
- 1—Devine, 90 sq. ft., Steel.
- 1—Devine, 115 sq. ft., Copper tubes.
- 1—Struthers Wells, 115 sq. ft., Stainless.
- 1—Alco, 157 sq. ft., Stainless.
- 5—Korbate, 187 sq. ft.
- 1—Western, 250 sq. ft., Stainless.
- 5—Struthers Wells, 275 sq. ft., Steel.
- 1—Struthers Wells, 315 sq. ft., Stainless.
- 1—Vogt, 352 sq. ft., Stainless.
- 6—Alco, 360 sq. ft., Steel.
- 1—General American, 370 sq. ft., Stainless.
- 1—S. & K., 400 sq. ft., Stainless.
- 1—Western, 430 sq. ft., Steel.
- 1—Struthers Wells, 500 sq. ft., Steel.
- 1—Struthers Wells, 536 sq. ft., Stainless.
- 1—Acme, 594 sq. ft., Copper tubes.
- 1—Nooter, 786 sq. ft., Stainless.
- 1—Downington, 850 sq. ft., Copper tubes.
- 1—Bufflovak, 1080 sq. ft., Stainless.
- 1—Vulcan, 1220 sq. ft., Stainless.
- 1—Croll-Reynolds Barometric type 52-B, neoprene lined, 4'4" x 14'.

#### HYDRAULIC PRESSES

- 1—H.P.M. Steeping Press, 88 tons.
- 1—H.P.M. Steeping Press, 63 tons.
- 1—Lab. Hyd. Press 8" x 8".

#### KEYTLES—REACTORS

- 1—Pfaudler 2 gal. glass lined, jacketed.
- 1—Patterson Kelly 50 gal., Steel, jacketed.
- 2—Dopp 80 gal., Steel, jacketed.
- 2—Dopp 150 gal., Steel, jacketed, agitated.
- 1—Pfaudler 250 gal., Hastelloy C, jacketed.
- 1—Walter 500 gal., stainless, jacketed, agitated.
- 1—650 gal., steel, jacketed, 150 psi.
- 4—Bufflovak 750 gal., Steel, jacketed, agitated.
- 2—Patterson 1000 gal., Steel, jacketed, agitated.
- 1—Blaw-Knox 1000 gal., Stainless, jacketed, agitated.
- 6—Struthers Wells 2000 gal., Stainless, jacketed, agitated.
- 1—Newman 3000# Steel, jacketed, agitated Crutcher.

#### LABELERS

- 5—World, National and Ermold Semi-Automatic, motor driven.

#### PEBBLE AND JAR MILLS

- 1—Abbe 9" x 3 1/2" silex lined Pebble Mill.
- 1—Abbe 4" x 3" silex lined Pebble Mill.
- 1—Abbe 5" x 6" silex lined Pebble Mill.
- 2—Abbe #1 Eureka Jar Mills, 9 gal.
- 1—Abbe double Jar Mill 2.6 gal. each.
- 1—Abbe 10 Jar Mill .8 pint each.

#### CRUSHERS—PULVERIZERS

- 1—Jeffrey 18" x 18" single roll Crusher, 10 HP.
- 1—Fitz Mill model D, Stainless, 7 1/2 HP.
- 4—Jeffrey 8" x 15", 12" x 20", Hammer Mills.
- 1—Williams #1 Heavy Duty Hammer Mill, 30 HP.
- 1—Fairbanks Morse Hammer Mill, 15 HP.

#### 1—Schutte type F Hammer Mill, 50 HP.

- 1—Williams Hammer Mill, 5 HP.
- 1—Raymond #200 Screen Mill, 10 HP.
- 5—Day, Kent and Mead Cage & Disc Mills.
- 2—Day 18" dia. Pressure type Ointment Mills.
- 2—Stokes 8" dia. Drug Mills, 1/2 HP.

#### MIXERS

- 1—55 gal. Drum Rolling, 3/4 HP.
- 2—Day #9 "Cincinnati" double arm, 250 gal.
- 2—Day #6 "Cincinnati" double arm, 100 gal.
- 1—Baker Perkins #16 TRM double arm, vacuum, 150 gal., 60 HP.
- 1—Day #1 "Cincinnati" double arm, 10 gal.
- 1—Baker Perkins #14 double arm, 50 gal.
- 16—Day, Horizontal, Powder; 200, 400, 600, 1000 and 1500#.
- 1—10 cu. ft. "V" type Stainless, 2 HP.
- 1—Sprout Waldron 7000#, Horizontal, Powder, jacketed.
- 1—Robinson 10,000# Horizontal, powder, jacketed.
- 2—Abbe Aluminum, Horizontal, 400 and 1000#.
- 3—McClellan 1 cu. ft., Stainless, Conical.
- 1—Stokes 200#, granulating.
- 1—Ross 50 gal., Mammoth Change Can.
- 1—Eppenbach 1 HP Stainless Homa Mixer.

#### PUMPS

- 12—Nash Hytor Vacuum; #7, #2 #TS7, and #1251.
- 2—Stokes Microvac 10 and 115 cfm.
- 10—Mayno Rubber, Steel and Stainless, 1" to 4".
- 12—Proportioning; Roy, Lapp, Hills-McKenna, 75 gph to 705 gph, Stainless.
- 17—Durco Centrifugal; 1" to 4 1/2" Durion, Durimet, Chlorimet.
- 11—LaBour Centrifugal; 1" to 3", Stainless.
- 7—Taber Centrifugal; 1" to 3", Stainless.
- 3—Lawrence Vertical Centrifugal; 2 1/2" x 1 1/2", Stainless.
- 5—Worthite Centrifugal; 1" to 3", Stainless.
- 5—Oliver Centrifugal; 2" to 5", Olivite.
- 4—Quimby Centrifugal; 1" to 2", Rubber and Lead.
- 5—Wilfey Centrifugal; 4", Haveg.
- 23—Worthington, I. R., Deming, Dayton-Dowd; Centrifugal and Rotary; Iron and Bronze; 1" to 8".

#### VIBRATING SIFTERS

- 3—Robinson Triple Deck 30" x 104".
- 2—Rotex Double Deck 40" x 84".
- 3—Rotex Single Deck 60" x 84".
- 3—Robinson Single Deck 40" x 84", Stainless.
- 4—Sprout Waldron Single Deck 40" x 84", Stainless.
- 1—Link Belt Single Deck, 3' x 8".
- 1—Allis-Chalmers Multiple Deck, Low Head.

#### TABLET PRESSES

- 2—Stokes DDS2, DD2, Rotary, 7 1/2 HP.
- 1—Kux model 15-25, Rotary, 5 HP.
- 1—Colton model 10-35, Rotary, 2 HP.
- 5—Stokes Single Punch, models R, T, F.

#### TANKS

- 1—Haveg 1500 gal., Horizontal, 15 psi.
- 1—1000 gal., Stainless, Vertical, Closed.
- 1—300 gal., Stainless, Vertical, Closed.
- 1—200 gal. Stainless, Horizontal.
- 1—Pfaudler 60 gal., Glass lined, vacuum.
- 1—2000 gal., Steel, Vertical, Mixing.
- 1—4000 gal., Steel, Horizontal, 150 psi.
- 1—6000 gal., Steel, Horizontal, 75 psi.

# BRILL EQUIPMENT COMPANY

2401 THIRD AVENUE, NEW YORK 51, N. Y. Telephone: CYpress 2-5703

**JUST PURCHASED**

- 1—Link-Belt #604-18 Roto-Louvre Dryer, 6'-4" dia. x 18' long, w/ cyclone, fans, etc.
- 1—Link-Belt #310-20 Roto-Louvre Dryer, 3'-10" dia. x 20' long.

**STOCK ITEMS****STAINLESS STEEL REACTORS—  
KETTLES**

- 3—3,500 gal. Struthers Wells T316 SS kettles, jack coils, 40/20 HP agit.
- 2—2,200 gal. reactor, T316 SS, vacuum internal, 45# jkt., vertical agit.
- 2—1,850 gal. reactors, T316 SS jack.
- 1—1,400 gal. jacketed kettle, T304 SS, 5 HP XP agit.
- 1—1,400 gal. reactor, T316 SS, ASME 175# IWP, jacketed, 20 HP XP agit.
- 2—750 gal. T304 SS kettles, 30# IWP, 30# jacket, 10 HP XP agit.
- 1—750 gal. T304 SS reactor, jacketed, 10 HP agit.
- 2—500 gal. T316 SS reactors, vacuum, jacket, 7½ HP agit.
- 1—350 gal. reactor, T304 SS, vacuum, jacketed, 3 HP agit.
- 5—465 gal. reactors, T304 SS, 175# IWP, 165# jacket.
- 1—600 gal. T304 SS evap. kettle.

**MILLS**

- 2—Raymond #5057 hi-side
- 1—Kennedy 4' x 8' rod mill, 50 HP
- 4—A-C 5' x 22' ball mills, 150 HP
- 1—Traylor 8' x 11' ball mill, 300 HP
- 1—Penna. non-clog swing hammermill, 400 HP, UNUSED, 48" x 60"
- 1—Hardinge 4'6" x 16" conical ball mill.
- 3—Jaw Crushers: 36" x 15", 20" x 6".

**ROTARY KILNS—DRYERS**

- 1—11' x 155' Traylor, ¾" shell Kiln.
- 1—9' x 100' Vulcan, ¾" shell Kiln.
- 1—8' x 125' Kiln, ¾" shell.
- 1—8' x 115' ¾" shell, 2-tire Kiln.
- 2—7'6" x 100' ½" shell Kilns.
- 1—7'6" x 60' Kiln, ½" shell.
- 4—Hardinge 8'6" x 7' Dbl. shell dryers, #XA-18, welded, ¾" shell.
- 1—7'6" x 65' dryer, ½" welded shell.
- 1—Allis-Chalmers 7' x 50' dryer.
- 1—6' x 50' Louisville dryer.
- 6—Steel dryers, 5'6" x 50', 4'3" x 32', 4'6" x 40', 4'6" x 32', 4' x 30', 3' x 15'.
- 2—Stainless dryers: 4'6" x 12', 3' x 10'.

- 24—SHARPLES #16 Super Centrifugals, Inconel bowls, stainless steel covers, 3hp TEFC motor.

# 3 MILLION DOLLAR LIQUIDATION

## Type 316 Stainless Steel Equipment CHEMICAL PLANT—ORANGE, TEXAS

**TYPE 316 STAINLESS STEEL TANKS**

- 1—17,850 gal. 9' dia. x 36' long, T316 SS, ¼" shell, ¾" heads w/coil.
- 12—2,300 gal. 7' dia. x 8' high, T316 SS, ¼" shell, coils (some with agitator).
- 5—2,200 gal., T316 SS, 6'6" dia. x 8' high, jacketed.
- 2—2,000 gal. 6'6" O.D. x 8' long, ¼" shell.
- 1—1,900 gal., T316 SS, 6' dia. x 8' high, VACUUM.
- 4—1,200 gal. 5' dia. x 7' high, dished top, 42" deep conical bottom (crystallizer tanks).
- 7—560 gal. 3'6" dia. x 7' high, ¼" dished top, 4' deep conical bottom.

**STAINLESS STEEL COLUMNS**

- 1—110" Dia. Vulcan scrubber, 10 trays on 12" centers, 252—bubble caps per tray.
- 1—86" dia. x 13' high scrubber, 10 stainless steel trays on 12" centers, 276—caps.
- 2—86" dia. x 35' high bubble cap columns, 30 trays, 12" spacing, 272—caps per tray.
- 2—60" dia. x 13' high, Vulcan scrubbers, ¼" shell, 10 trays, 100—caps per tray.
- 1—48" dia. column, 25 trays, bubble caps, T304-ELC, 100# WP.
- 3—30" dia. packed columns, 25' high, T316 SS.
- 3—24" dia. bubble cap columns, 12 trays, T316 SS, 18" spacing—Vacuum.

**COPPER COLUMNS**

- 1—72" dia. Vulcan bubble cap copper column, 46'10" high, 40—trays—Vacuum.
- 2—48" dia. bubble cap copper columns, 25 & 40 trays, 31' & 45' high—Vacuum.
- 2—42" dia. Vulcan stills, 56" high. (Evaporator bodies).
- 1—24" dia. column, 25'8½" long, 20 trays, bubble caps.

**FILTERS—CRYSTALLIZERS**

- 1—Alco 110 sq. ft. T316 SS pressure leaf filter.
- 2—Sharples C-20 Super-D-Hydrators T316 SS.
- 3—16,000 gal. Aluminum Cone bottom tanks, 12' dia. x 31' O.A.H.
- 4—1,200 gallon Crystallizers, T316 SS, 5' dia. x 7' high, dished top, conical bottom.
- 7—560 gal. Crystallizers, T316 SS, 3'6" dia. x 7' high, dished top, conical bottom.
- 3—Worthington 160 Ton steam jet refrigeration units.

**TYPE 316 STAINLESS STEEL KETTLES**

- 3—3,500 gal. jacketed kettles, 7' dia. x 12' high, T316 SS, 11/32" shell, dished heads, 11 turns SS coil, two-speed agitator, 40/20 HP-1750/500 RPM.
- 1—2,500 gal. 6' dia. x 12' high, T316 SS, horiz. still kettle.
- 1—2,200 gal. jacketed reactor, T316 SS, vacuum int., agit.
- 2—1,850 gal. jacketed reactors, T316 SS, vert. agit.

**CONDENSERS—HEAT EXCHANGERS—CALANDRIAS—COOLERS**

- 1—1,450 sq. ft. condenser, stainless steel tubes, tube sheets, heads, and baffles.
- 1—1,200 sq. ft. condenser, stainless steel tube, steel shell.
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- 1—Patterson-Kelley 6000 gal. steel jacketed reactor, 40# jacket, complete with agitator and drive.

### DRYERS

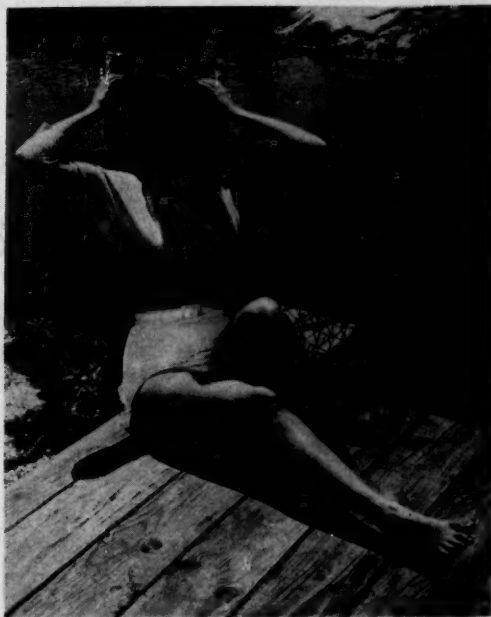
- 1—Link Belt steel roto louver dryer, Model 1003-30
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- 1—Niagara SS filter, Model 510-28
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- 1—Oliver horizontal filter, 3'
- 1—Oliver type 316 SS rotary vacuum precoat filter, 3' x 4'
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- 1—Tolhurst type 347 SS 40" suspended type centrifuge with perforated basket



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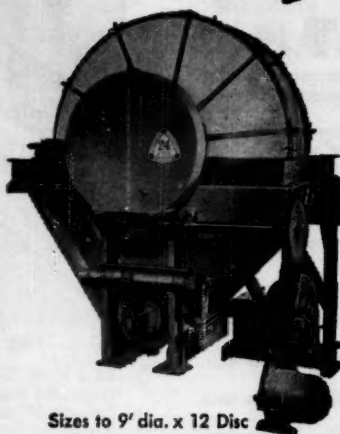
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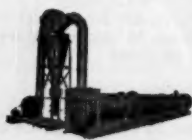
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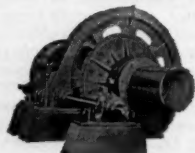
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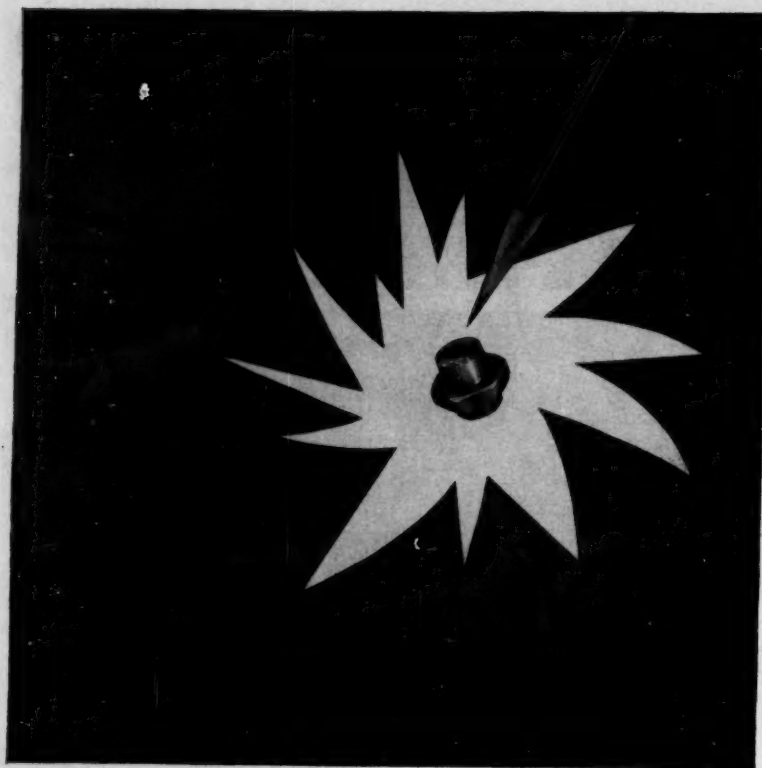
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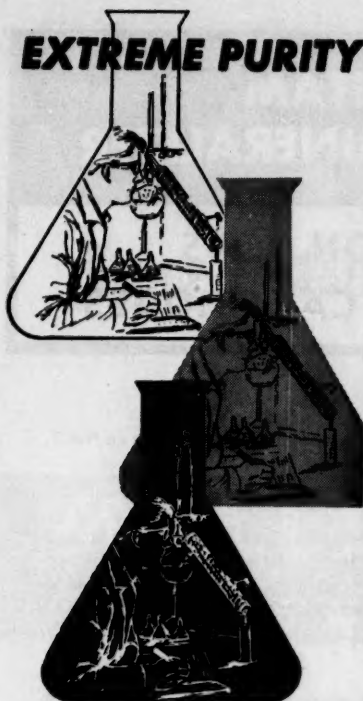
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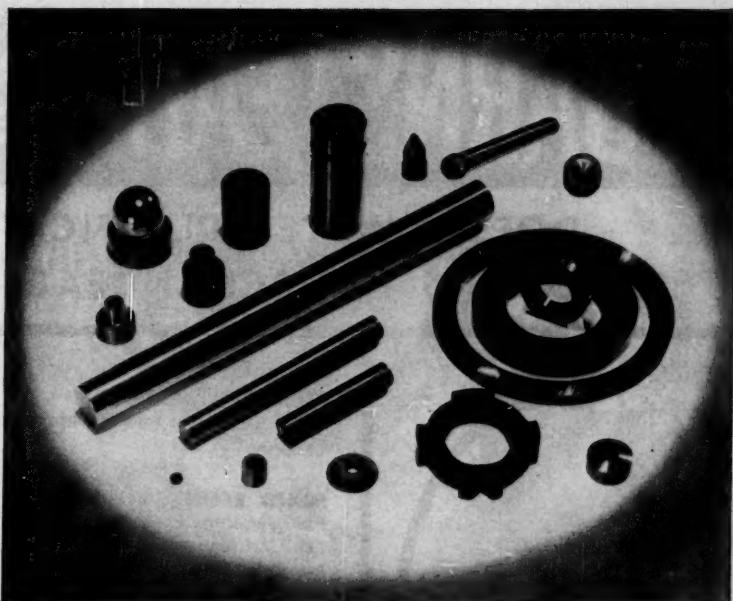
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Provides (1) precious metals recovery, (2) radio-active isotope recovery, at low cost, (3) also useful for removing volatile amines where heating plant steam condensate is being used as the feedwater for a Still, and (4) where close control over the pH of water is necessary, the cation cartridge in its ammonia or lithium form is effective.

Whatever your Pure Water problem . . . look to Barnstead for the right answer . . . Barnstead manufactures a complete line of Stills, and Demineralizers in capacities of from  $\frac{1}{2}$  to 2500 gallons per hour. Write for Catalog G on Water Stills and Catalog 127-A on Water Demineralizers.

**B** TRADE MARK REG. U.S. PAT. OFF.  
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4 Lanesville Terrace • Boston 31, Mass.

Shown at right: Barnstead Pressure Bantam Demineralizer. Delivers demineralized water under pressure. Flow rate 8 to 25 gallons per hour. Indicating light shows when cartridge needs replacement. Takes same cartridge, does same jobs as regular Bantam Demineralizer.



PURE WATER SPECIALISTS SINCE 1878

# Every Installation

# JOB ENGINEERED

## WILFLEY ACID PUMPS

Individual engineering on every application is standard practice with Wilfley. This personal attention to your specific requirements, plus Wilfley's day-in, day-out dependability, guarantee low cost pumping. Put a Wilfley Acid Pump to work... it will give you continuous, trouble free service, higher output and longer pump life.

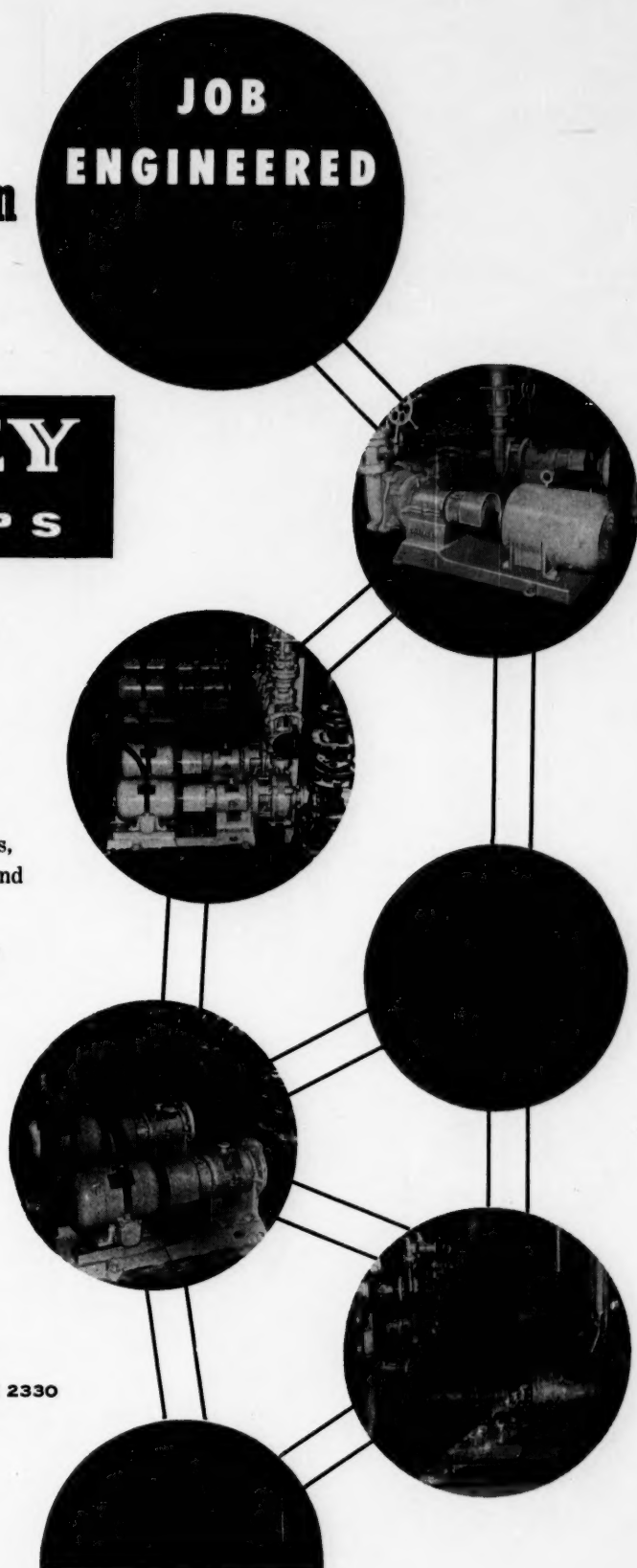
Wilfley Acid Pumps are available with pumping parts of machinable alloys as well as plastic to meet every need in the handling of corrosives, hot liquids and other difficult solutions.

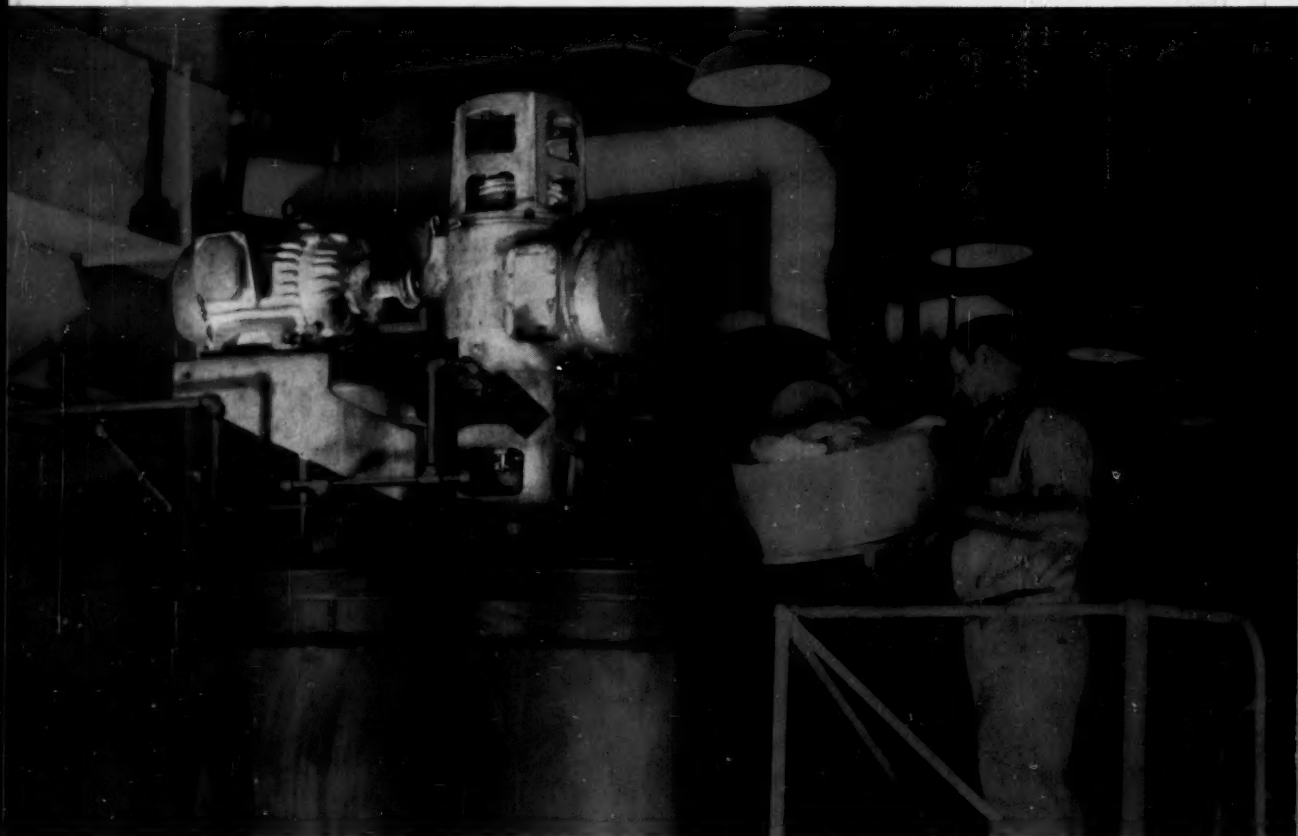
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Avery Adhesive Label Corporation

## Good mixing pays for itself in 15 months

Engineers found gold in this rubber-cement tank—when they stepped up the mixer horsepower.

Into the tank every day go 800 gallons of hexane. Then an operator feeds in 700 pounds of synthetic rubber. Mechanical mixing helps the rubber dissolve. The resultant cement goes onto self-sticking labels used throughout industry.

But until recently, production men were having trouble dissolving the rubber in the hexane. The only method that worked was to shred the rubber small as popcorn before charging it to the tank. Even then, dissolving was

slow. The whole operation took 20 man-hours.

Then one day, a LIGHTNIN Mixer representative stopped in at this company's request and studied the mixing job. He recommended a fivefold increase in power transmitted to the mix.

Soon a 25-hp turbine-type LIGHTNIN Mixer was installed on this tank and on each of two others like it, replacing older 5-hp units.

**Time cut in half** Now it's no longer necessary to shred the rubber. A man dumps it into the three tanks in big thick slabs. The LIGHTNIN Mixers drive

solvent and rubber in a powerful flow throughout the tanks to promote rapid, uniform dissolving.

All the rubber dissolves in nine hours—better than twice as fast as before. And savings are \$7,000 per year—enough to pay for the three new mixers in less than 15 months.

This kind of fluid mixing is saving money every day for thousands of processors all over the country. It can save you money, too. For mixing that does what you want it to do—on a fully guaranteed basis—call in your LIGHTNIN Mixer representative now. Or write us direct.

*Lightnin Mixers*  
MIXCO fluid mixing specialists

### WHAT MIXING OPERATIONS ARE IMPORTANT TO YOU?

You'll find a wealth of information on fluid mixing in these helpful bulletins describing LIGHTNIN Mixers:

- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 hp (B-102)
- ☐ Top entering; propeller types: ¼ to 3 hp (B-103)
- ☐ Side entering: 1 to 25 hp (B-104)
- ☐ Portable: ¼ to 3 hp (B-108)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals (B-111)
- ☐ Data sheet for figuring mixer requirements (B-107)

Check, clip and mail with your name, title, company address to:

**MIXING EQUIPMENT Co., Inc., 128-j Mt. Read Blvd., Rochester 3, N. Y.**  
In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ontario

